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No. 1

## SOME EXPERIENCES WITH OLEOTHORAX\*

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ST. LOUIS, MO.

THE use of antiseptic oils in the treatment of infections of the pleural cavity has long been known. In fact, Hippocrates recommended that they be employed in their warm state after aspirations. Clive Riviere in 1919 experimentally tested the reaction of the pleura to gum solution. Although retained in the pleural cavity, this solution was found to excite considerable pleural reaction. Riviere therefore refrained from carrying out his original intention which was to treat patients suffering from bronchopneumonia by basal collapse. That the injection of massive quantities of oil into an infected pleural cavity might result in its disinfection or that the oil might serve to cause compression in the case of pulmonary lesions was therefore theoretically appreciated. It remained for Bernou to realize this possibility clinically. He so treated a patient in July, 1921, and to this form of treatment gave the name oleothorax.

Bernou's patient suffered from pulmonary tuberculosis but developed a bronchopleural fistula during the course of pneumothorax treatment. He started oleothorax treatment and soon obtained adequate compression. He therefore maintained the pneumo-oleothorax. The fistula became obliterated. Bernou did not advocate oleothorax as a method of choice in the treatment of bronchial fistulae. He did recommend it in the treatment of purulent tuberculous pleuritis.

We propose to report some of our experiences with oleothorax. They concern its employment in patients with tuberculous lesions of the pleura and lung. Some examples of its value as a supplement to pneumothorax in the treatment of bronchiectasis have also been included, and one case in which it was employed to supplement an incomplete thoracoplasty for pulmonary tuberculosis which had to be abandoned because of activity in the opposite lung.

### OIL USED

Vegetable oil and paraffin have been recommended. We employ the U. S. P. preparation of the latter. The oil is sterilized by heating. No further precautions are necessary. The gomenol is added after the sterilization of the oil. The fluid is cultured at intervals. Five cubic centimeters of 5 per cent gomenol are added to every 95 c.c. of liquid paraffin. Gomenol has been used in strengths up to 20 per cent. The stronger solution is indicated when antiseptic action, rather than mechanical action, is desired. For purposes of more exact roentgenographic visualization a few cubic centimeters of iodized oil or brominized oil may be added. The iodized oil usually remains at the bottom while the liquid paraffin goes to the top (see Fig. 3c).

We may here note that Chandler and Gloyne observed that when a sero-purulent

\* From the Department of Surgery and Chest Service, Washington University and Barnes Hospital, St. Louis. Submitted for publication Dec. 9, 1931.

fluid to which oil has been added is allowed to stand in a glass cylinder, it separates out into three layers, a layer of deposited

oil is under high pressure, the action is compressive.)

### 3. Disinfecting.

(Specific (?) bactericidal action of gomenol in certain cases.)

There can be no doubt that the two chief actions of oleo thorax are (1) detoxicating, and (2) mechanical. Oleo thorax helps to stabilize the mediastinum. The nutritive and tonic effects of the oil are said to be slight. Clerc of Leysin is of the opinion that gomenol possesses a specific bactericidal action in tuberculosis. Tulloch in 1926 reported that *B. tuberculosis* could be killed when dried by exposure to olive oil at 37°C., and that the lethal action of the oil was enhanced by the addition of oleic acid. Tulloch wished it clearly understood that no far-reaching conclusions could be drawn from his experiments. Ross and Tulloch later reported that olive oil, even of so low an acid value as 0.09 per cent, is lethal to tubercle bacilli in ninety-six hours at 37°C. Interesting cultural studies have also been made by Waitz.

Since oleo thorax always follows pneumothorax we will first briefly discuss the changes in the lung which follow the latter. They have been referred to in detail by Bruns and others. Henius has shown that the consequences of continued and repeated pneumothoraces are thickening of the pleura and interlobular septa, formation of connective tissue which grows from the interlobular septa and capsulation of the process in the lung. Kaufmann and Tomazewski made similar observations.

Archibald in 1922 found that liquid paraffin produced a mild inflammatory action in the pleura of animals. Severe reactions seldom occur. Chandler and Gloyne state that in the majority of cases the injection of liquid paraffin, lipiodol and gomenol into the pleural cavity results in soft oleaginous adhesions. Connective tissue and newly formed capillaries may also result. No local or remote harmful results were noted. My own observations are similar in this respect. They also con-

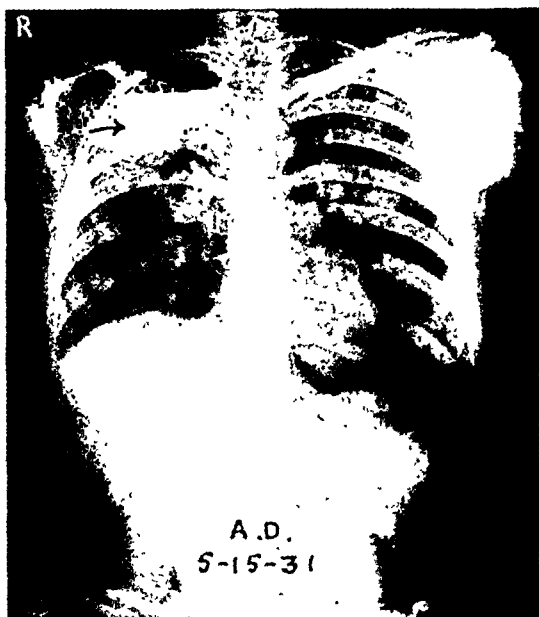


FIG. 1. Pulmonary tuberculosis, right, in female, aged twenty-five. Symptoms first noted in 1925. Pneumothorax treatment was started on Jan. 10, 1928. Phrenicectomy, right, was performed elsewhere on April 5, 1930. Lung was allowed to partially reexpand but spread of lesion necessitated further pneumothorax treatment. Good collapse of apex was only possible then. Oleo thorax treatment started early in 1931. Figure (5-15-31) shows appearance of oleo thorax cavity following introduction of 30 c.c. of liquid paraffin which contained a few cubic centimeters of 5 per cent gomenol. Pneumothorax cavity was later completely filled with oil. Total amount of oil used in this case was 115 c.c. Perhaps this patient may sometime become suitable for thoracoplasty.

cells, bacteria and debris at the bottom, then a layer of serous fluid, and finally one of oil floating on top.

#### ACTION OF OLEO THORAX

The action of oleo thorax has been adequately grouped somewhat in the following manner by Gilbert:

##### 1. Detoxicating.

(Pleural layers made thick, rigid, impermeable; absorption of toxins decreased.)

##### 2. Mechanical.

(The action is blocking when the cavity is completely filled; when the

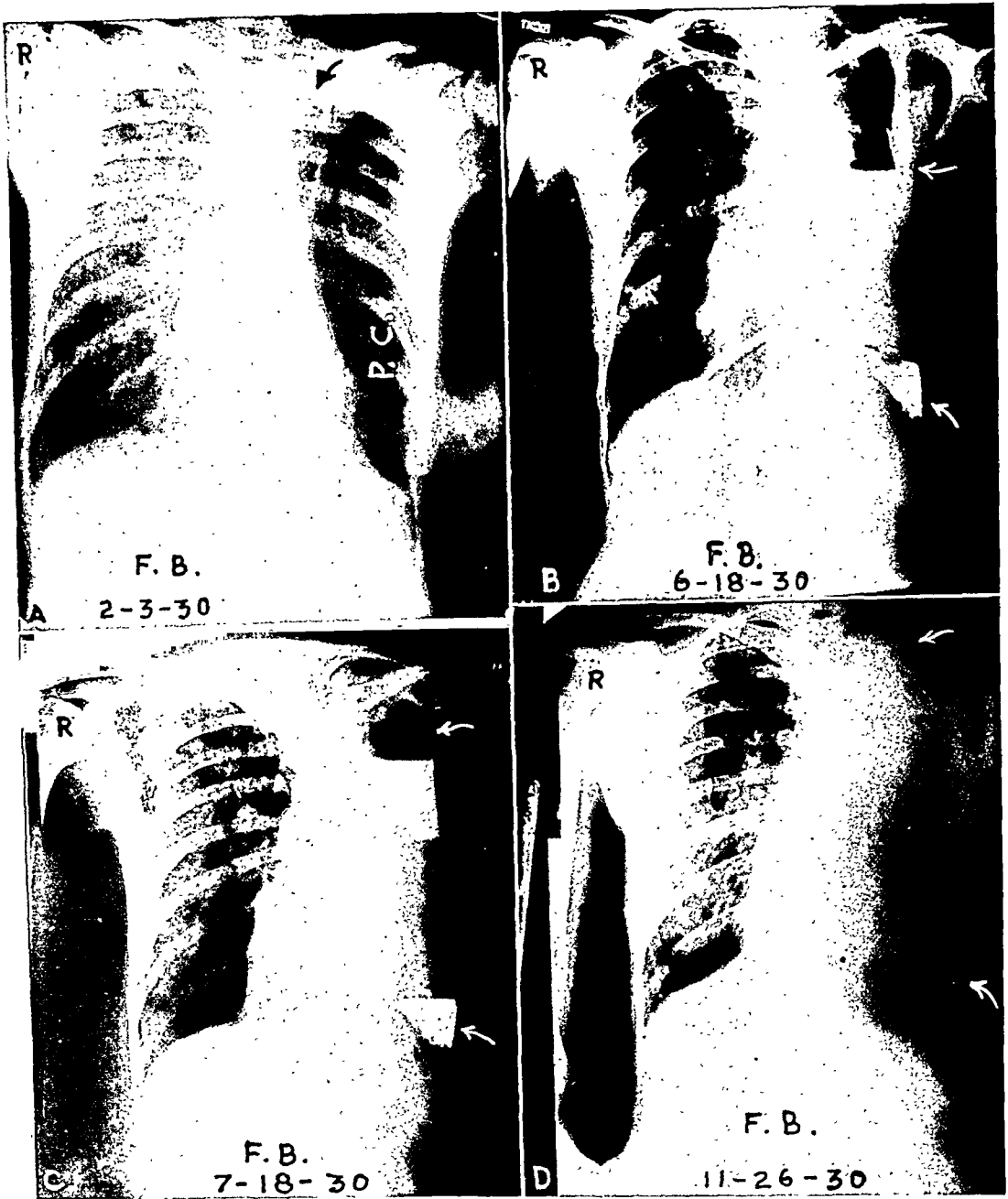


FIG. 2. Pulmonary tuberculosis, left, in female, aged thirty-eight. P.C. Pneumothorax cavity. Arrow in A, Feb. 3, 1930, indicates large uncollapsed apical cavity. Phrenicectomy, left, performed Feb. 6, 1930. For economic reasons, thoracoplasty undertaken and segments of 11th, 10th, 9th, 8th and 7th ribs removed by Dr. E. A. Graham, Feb. 19, 1930. Portions of 6th, 5th, 4th and 3rd ribs removed March 18, 1930. (B) Patient developed purulent pleural effusion, left, and signs of activity in opposite lung. Oleothorax treatment therefore undertaken. Upper arrow in B, June 18, 1930, indicates position of fluid level, lower arrow some of lipidol which has dropped to bottom. C, July 18, 1930, indicates some of regenerated ribs and also that pneumothorax pocket is gradually being filled with oil. In lateral position both fluid levels (indicated by arrows) became one. D, November 26, 1930, shows that apical cavity has been completely collapsed by oleothorax. Patient has remained free from cough and expectoration for over a year and a half and has not required any further refills. Fluid in left pleural cavity has remained sterile.

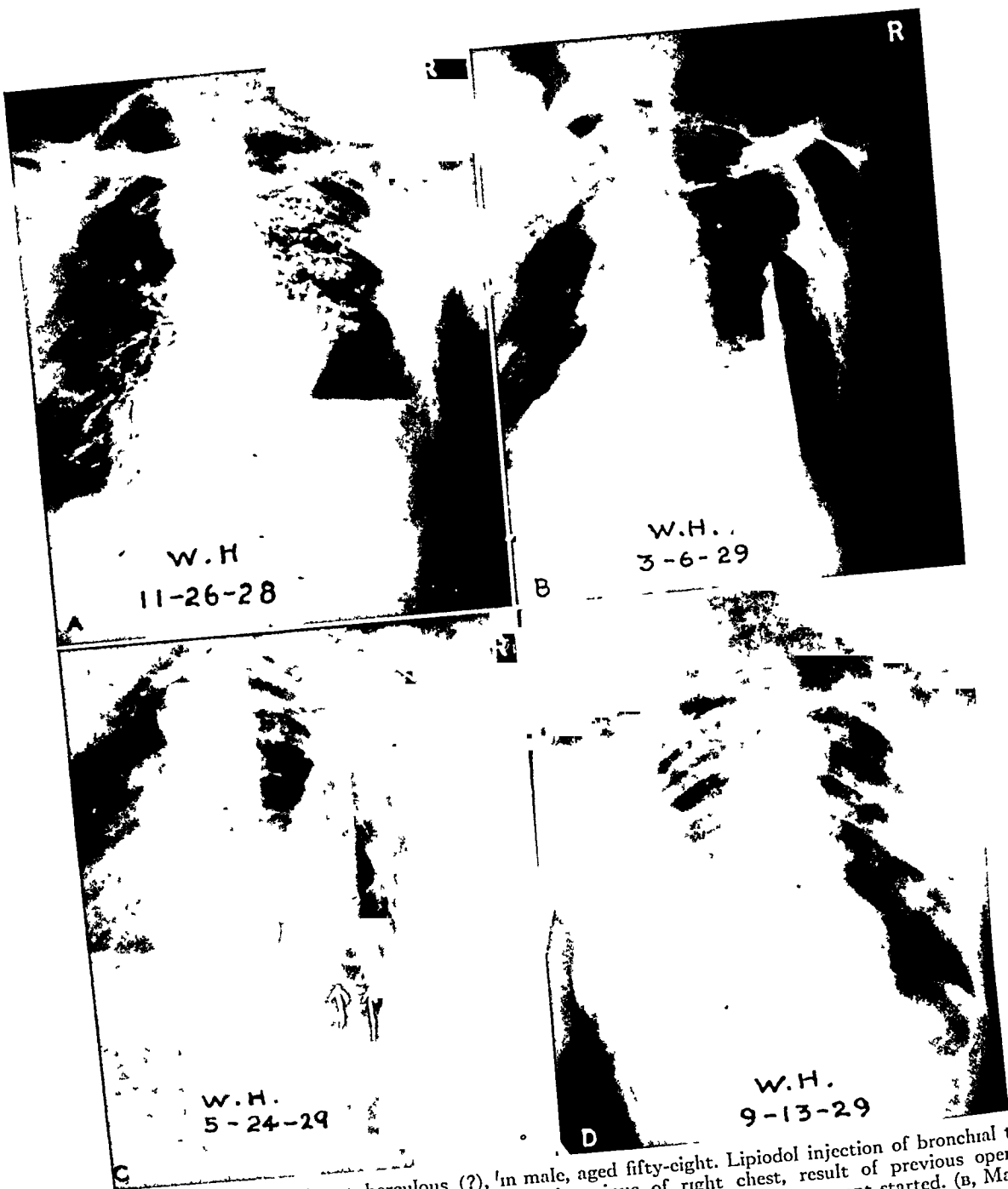


FIG. 3. Seropurulent pleurisy, tuberculous (?), in male, aged fifty-eight. Lipiodol injection of bronchial tree is normal. (A, Nov. 26, 1928.) Patient had discharging sinus of right chest, result of previous operation. Opening of wound was drawn together with strips of adhesive and oleothorax treatment started. (B, March 6, 1929.) In C, May 24, 1929, one can observe three definite fluid levels. Lowermost contains lipiodol. Pleural fluid which is present lies between it and paraffin. It was possible to completely fill cavity in left chest with oil. (Note: "films" B and C were taken with patient's affected side uppermost.) (D, Sept. 13, 1929.) Patient's temperature returned to normal following first oleothorax treatment. External wound healed and patient remained free from all complaints referable to right chest until time of his death from carcinoma of esophagus. Right pleural cavity found to be quite clean and although one inoculation of a guinea pig had shown evidence of tuberculosis, this could not be substantiated at necropsy.

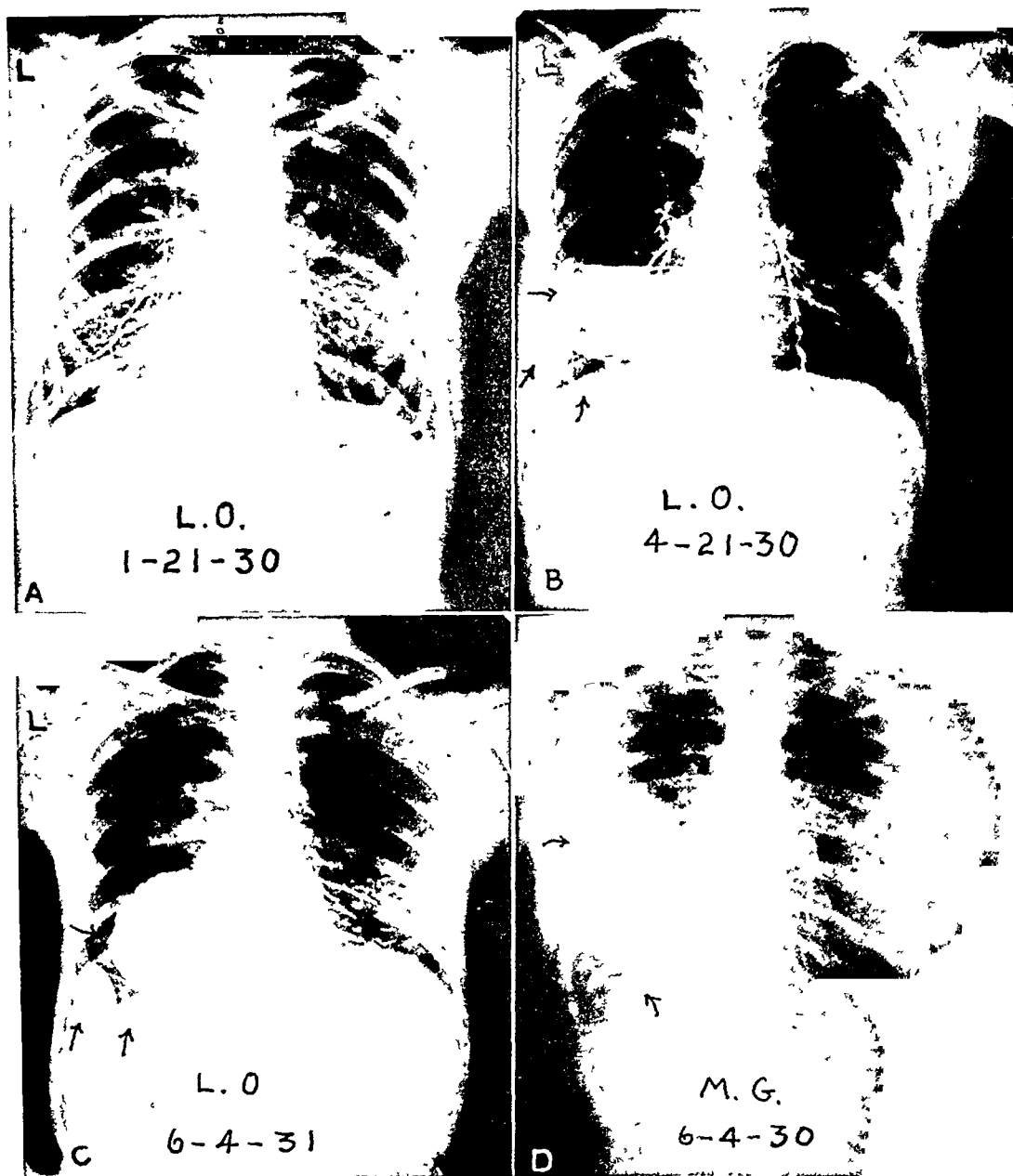


FIG. 4. Bilateral bronchiectasis in male, aged twenty-two. (A, Jan. 21, 1930.) Films taken during various stages of oleothorax treatment are noted in B and C. Oil separated off into numerous pockets. Uncollapsed dilatations indicated by lowermost arrows in B and C. Patient had previously received pneumothorax treatment for a considerable period and also had a phrenicectomy, right, performed on May 17, 1930. Collapse therapy in this case was ineffective. Patient died at his home during October, 1931. D. Bronchiectasis, left. This patient (see last case report) was first given postural drainage and then pneumothorax treatment. This treatment was later supplemented by a phrenicectomy, left. Pneumothorax pocket gradually began to obliterate. Oleothorax treatment was therefore started. Size of oleothorax cavity (o) is indicated by arrows, type of dilatations by lowermost arrow. Patient has remained improved following this treatment and has not required any refills for over twenty months.



firmed those of J. S. Young who found that the injection of 10 c.c. of liquid paraffin into the pleural cavity of a rabbit consistently failed to excite epithelial proliferation. The same could be said for liquid paraffin in combination with gomenol and lipiodol. Young occasionally noted a perceptible degree of swelling in the serosal endothelium and in the peripheral epithelium during the first two or three days following the injection, but these changes were relatively insignificant.

Waitz has also reported on experimental oleo thorax. The animals used were rabbits and guinea pigs. He employed olive oil mixed with oil of sesame. In some instances 8 per cent gomenol was added. He observed a fibrinous reaction in the pleura twenty-four to forty-eight hours after the introduction of the afore-mentioned oil into the virgin pleural cavity of a female guinea pig. The amount of oil present was considerably less than that injected. If, on the other hand, oil of gomenol was injected, the amount of fluid noted at necropsy was more than had originally been injected. From this he concluded that the resorption of the oil is followed by an uncompensated exudation. Many fat droplets and a few leucocytes and lymphocytes could be recognized microscopically. In a second group of animals allowed to live for some time stronger deposits of fibrin and a small amount of fluid were observed on the opposite side.

Three rabbits which I treated with liquid paraffin and gomenol and lipiodol at intervals over a period of nineteen months failed to develop any such changes in the contralateral pleural cavity. We believe that the oil disappears from the pleural cavity much more slowly in those animals which received pneumothorax treatment and then oleo thorax.

Gomenol and paraffin mix with the effusion to some extent and it would seem that a path of absorption is along the subpleural lymphatics. Waitz observed peribronchial infiltrations.

Chandler and Gloyne found no evidence of lipolytic activity. In rabbits experimentally infected with tuberculosis they found that the adhesions induced by gomenol showed histological evidence of tuberculosis.

It is worthy of note that Young observed that superficial or deep trauma of the lung by the needle was regularly followed on or before the third day by active proliferation of surrounding epithelial and connective cells.

To repeat, the use of liquid paraffin in the pleural cavity is not attended by any necrosis or by any striking hyperplastic or proliferative changes in the pleura or adjacent lung. It should be noted, however, that a case of mediastinal paraffinoma has been recorded by Fontaine (cited by Sillig and Lang).

#### INDICATIONS FOR OLEO THORAX

We employ oleo thorax in pulmonary tuberculosis as an aid to pneumothorax when the collapse is ineffective due to insufficient compression or when the pleural space is becoming rapidly obliterated. A phrenicectomy may be performed with profit before or after oleo thorax in certain cases. Oleo thorax may also be employed in purulent and non-purulent tuberculous pleurisy. Our experience to date has not been very gratifying in cases of secondarily infected tuberculous pleurisy. Oleo thorax may be used to help stabilize the mediastinum preparatory to a thoracoplasty or as an adjunct to an incomplete thoracoplasty. It may also be recommended in the presence of a small bronchopleural fistula, and certainly as a substitute for a pneumothorax for economic reasons. Its use has also been suggested in patients in whom pneumothorax treatments are followed by a reaction.

Oleo thorax may be employed in the treatment of bronchiectasis for purposes of compression. It may also be of value in cases of spontaneous pneumothorax. In the presence of a recurrent serous effusion

it may help to create adhesions and to obliterate the pleural space.

Oleothorax is contraindicated in the presence of a large bronchial fistula and during the acute stage of serofibrinous pleurisy. We employed oleothorax in one case of a secondarily infected effusion due to carcinoma of the lung without success. The empyema was subsequently drained. Oleothorax should be tried in uninfected pleural effusions due to new growth, however, because it may obviate the necessity of repeated aspirations.<sup>1</sup>

#### TECHNIQUE OF OLEOTHORAX

The technique of oleothorax which we employ is as follows: Under local anesthesia the pleura is punctured as in a pneumothorax treatment. If a pneumothorax is already present we gradually aspirate the air by means of a pneumothorax machine, and replace it with oil. It is not always necessary to aspirate the pus which may be present. A few cubic centimeters of oil are first given to determine the patient's tolerance. The first injection should not exceed 100 c.c. The procedure should be controlled fluoroscopically. The injections are repeated until the cavity is filled. High intrapleural pressure should be avoided. We usually employ the same sized needles for oleothorax as we do for pneumothorax treatment. In some cases we introduce two needles, recording the pressure from the uppermost one. The patient usually lies in the lateral decubitus position with the affected side up.

#### CLINICAL EXPERIENCES

We have employed oleothorax in several patients with secondarily infected tuberculous pleurisy without effect. One patient had a discharging sinus, the result of a previous rib resection. She succumbed eight months after the first oleothorax treatment from tuberculous pneumonia. The oleothorax did not play a part in the final outcome. In the second case rib

resection became necessary because the oleothorax did not influence the temperature curve or obliterate the patient's bronchial fistula. A third patient with a secondarily infected tuberculous pleurisy received oleothorax treatment for some time following a rib resection. His empyema cavity has since become completely obliterated but it is doubtful if the oleothorax influenced the end result appreciably.

We have employed oleothorax chiefly as a means of obtaining and maintaining compression which was no longer possible by other methods.

The following more or less typical record of a patient suffering from pulmonary tuberculosis illustrates the use of oleothorax for purposes of compression and in preparation for possible thoracoplasty.

CASE 1. Female (A. D.), aged twenty-five; complaints: cough, expectoration (positive sputum) and hemoptysis. Onset in December, 1925. Sanatorium care for five years during which time the patient received sanocrysin without benefit. Pneumothorax treatment was started January 10, 1928. The lesion at that time was confined entirely to the right upper lobe. She did very well under pneumothorax treatment and the cavity which was present seemed to be collapsed. She developed small amounts of fluid in the right pleural cavity at intervals. A phrenicectomy was performed on April 5, 1930, with the idea that the lung might be allowed to reexpand. Sputum at this time was negative, but the films of August 1, 1930, suggested further extension of the process even though the sputum remained negative. Pneumothorax treatment was again started but collapse of the apex of the lung only could be obtained. Fearing that the small air pocket which remained might become obliterated, she was given oleothorax treatment. The first four injections were 5 c.c., 5 c.c., 10 c.c., and 20 c.c., respectively, of 1 per cent gomenol and paraffin oil. The patient received this treatment at the Maybury Sanatorium situated at Northville, Michigan. It was decided to continue the oleothorax treatment when the patient presented herself at the Medical and Surgical Chest Service, Barnes Hospital. On May 11, 1931, 30 c.c. of a similar mixture of oil, save for the fact that the gomenol was 5 per cent,

<sup>1</sup> Baumgarten and Rusk have obtained good results in two such cases.

were injected into the pleural cavity. The initial pressure was  $-2, 0$ . On May 15, 1931, 55 c.c. of oil were injected. The patient's fever and complaints were much improved following these injections and it has not been necessary to give her any further treatment up to the present time. The last roentgen ray film, however, suggests that there is an extension of the lesion below the oleothorax but with rest in bed it is hoped that this patient may eventually become suitable for more adequate collapse therapy, namely, thoracoplasty. (Fig. 1.)

The following case, recorded in detail, is most instructive because the oleothorax apparently prevented a purulent effusion from becoming secondarily infected, and, in addition, served to compress a cavity in the lung. Two stages of a thoracoplasty had previously been undertaken in this case but had to be abandoned because of the development of activity in the opposite lung.

**CASE II.** Female (F. B.), aged thirty-eight, admitted to Barnes Hospital on January 28, 1930. Complaints were cough and expectoration of eighteen months' duration (positive sputum), weakness of fifteen months' duration and loss of 15 pounds in weight during the three months previous to admission.

**Family History:** The patient's mother died of tuberculosis in 1927. The patient was exposed for a period of seven months; her symptoms developed three months after her mother's death.

**Past History:** Scarlet fever at twelve, became deaf in left ear following this disease; measles at eighteen. Married for sixteen years; has three children, alive and well.

**Diagnosis:** Chronic pulmonary tuberculosis with cavitation, left upper lobe.

**Treatment:** Sanatorium care for six months, received pneumothorax treatment which was continued at the Chest Clinic, Barnes Hospital, up to the time that a phrenicectomy was performed on February 6, 1930. A first stage thoracoplasty was performed on February 19, 1930 by Dr. Graham because the apical cavity remained uncollapsed; and for economic reasons. Portions of the 11th, 10th, and 9th ribs were removed. The second stage was performed on March 18, 1930, when portions of the 8th,

7th, 6th, 5th, and 4th ribs were removed. The patient then developed signs of an acute tuberculous infection in her opposite lung and also a pleural effusion on the affected side. Cough and expectoration became marked. On June 18, 1930, 250 c.c. of clear straw colored fluid were obtained from the left chest. On July 16, 1930, 400 c.c. of purulent fluid were obtained, and because it was feared that the patient might develop a true secondarily infected empyema, oleothorax treatment was started. She was given 100 c.c. of a mixture of liquid paraffin, gomenol 5 per cent, and lipiodol on July 18, 1930, and 15 c.c. on July 21, 1930. These injections were preceded by aspirations of some of the pleural fluid present. The oleothorax treatment resulted in a collapse of the apical cavity and the complete disappearance of the patient's cough and expectoration. She has been steadily improving since then and has required no refills. It may be possible in this case to complete the thoracoplasty at a future date if it is deemed necessary. There is no doubt as to the value of oleothorax in this case. (Fig. 2.)

The chief interest in the following case lies in the fact that this patient, who had a pleural effusion and sinus of the chest wall became afebrile following the first oleothorax treatment. He remained afebrile up to the time of his death which was due to carcinoma of the esophagus. The external chest wound healed following oleothorax treatment. There is some doubt as to the true nature of the pleural lesion since necropsy failed to reveal any evidence of tuberculosis.

**CASE III.** Negro male (H. W. H.), fifty-eight years old, was first admitted to Barnes Hospital on March 23, 1928, when he was found to be suffering from a serofibrinous pleurisy. Repeated cultures of the fluid failed to show a growth. Guinea-pig inoculations were negative for tuberculosis. The fluid in the right pleural cavity gradually became purulent. It was therefore drained on April 21, 1928. Since the pleural fluid never became secondarily infected a first stage thoracoplasty was performed. Another guinea pig was injected with the pleural fluid at this time and was reported to be positive for tuberculosis. This fact was never again substantiated. The patient

was discharged on June 7, 1928. He was readmitted on November 13, 1928. A malignant process in the pleura was then suspected. A lipiodol injection showed a relatively normal bronchial tree. Thoracoscopy was performed on December 4, 1928, and revealed many irregular grayish yellow nodules and some few fine adhesions. The patient was again operated upon by Dr. Graham on January 5, 1929. An incision was made through the old scar. The parietal pleura was 1 cm. thick. About 250 c.c. of bloody fluid were found in the pleural cavity. There were also several masses of fibrin. Both pleural surfaces were smooth but here and there there was a suggestion of small nodules beneath the visceral pleura. Pieces of thickened parietal material and necrotic material were removed for microscopic examination and were subsequently reported upon as chronic inflammation. The cavity measured over 300 c.c. shortly after operation. One month later it measured 270 c.c. The patient was having a moderate fever. On March 5, 1929, there was still a moderate amount of purulent discharge. Very little fluid was, however, to be observed in the pleural cavity when the patient was fluoroscoped. There seemed to be no obvious contraindication to performing oleothorax. The fever was considered to be due to chronic pleuritis. Sixty-five cubic centimeters of paraffin oil and 10 c.c. of lipiodol with gomenol were injected into the right pleural cavity. There was no immediate reaction. The drainage tube which was still present was removed. The opening of the wound was drawn together with strips of adhesive. One hundred cubic centimeters of liquid paraffin were injected through the sinus which still permitted introduction of a needle on March 11, 1929. The patient had previously been febrile and it was noted that his temperature returned to normal immediately following the first oleothorax. On March 26, 1929, another 60 c.c. of liquid paraffin were injected. The external wound was now practically healed. The patient was discharged and reported for further treatment at the Chest Service. Some oil was removed from the pleural cavity on June 21, 1929. It was cultured, both aerobically and anaerobically. No growth was obtained. The patient received further injections of oil at intervals. (Fig. 3.)

Some time later, the patient began to complain of dysphagia. He was esophagoscoped on August 22, 1929, and it was found that a mass

was apparently pressing on the lumen of the esophagus in its mid-portion. Repeated attempts were made to endeavor to prove the presence of a carcinoma of the esophagus. The patient was symptom free as far as his pleural effusion was concerned. He was afebrile. An x-ray of the pelvis about this time revealed a metastatic process.

The patient died on November 6, 1929. Necropsy by Dr. H. McCordock revealed a carcinoma of the esophagus with metastases to the lungs, lymph nodes, bones and intestines. The right pleura was definitely thickened but the pleural cavity which contained oil was quite clean. The pleura showed no evidence of tuberculosis or carcinoma.

The following cases are presented because they illustrate the use of oleothorax in the treatment of bronchiectasis. The limitations of compression are illustrated in the first two cases, but a rather striking result was obtained in the third.

CASE IV. Male (L. O.), aged twenty-two. His chief complaints were cough and foul expectoration. They had been present since childhood. The expectoration amounted to several cupfuls per day. Physical examination including a lipiodol injection confirmed the diagnosis of bilateral bronchiectasis. The patient had marked clubbing of the fingers and toes. He was found to be suffering from pansinusitis but would only submit to incision and drainage of the right maxillary. This was carried out on February 25, 1930. Pneumothorax treatment, left, was started on March 17, 1930. The initial pressures were  $-2, 0$ ; 25 c.c. of air were injected; the final pressures were  $-1, +2$ . Seventy-five cubic centimeters of air were injected on March 19; 25 c.c. on March 21; 100 c.c. on March 24 and 100 c.c. on March 28. The final pressures were then found to be  $-2, +4$ . The last pneumothorax refill was given on March 31, 1930, when the initial pressures were  $-8, -2$ , and the final pressures  $-2, +4$ .

It was then decided to give the patient an oleothorax. This was done by Dr. H. M. Wilson. He introduced two needles into the pneumothorax pocket and obtained negative readings. Forty cubic centimeters of liquid paraffin were then injected. The second oleothorax was given on April 7, 1930, when 60 c.c. of the same mixture were injected. Another 60 c.c. were

injected on April 12, 1930, which made a total amount of 160 c.c. of liquid paraffin. It was found that the oil was separated off into several pockets and that further injections were impossible. This oleothorax gave moderate collapse but improved the patient's cough and expectoration very slightly. A phrenicectomy, right, was performed by me on May 17, 1930. The diaphragm rose but little. Following this procedure the patient developed some dyspnea which partly disappeared gradually. In this case the combined treatment was ineffective. This patient died at his home during October 1931. The limitations of bilateral collapse therapy in this case are obvious. (Fig. 4.)

Another patient with bronchiectasis treated with oleothorax clearly illustrates that it is necessary to take the roentgen-ray films in various positions. The lateral film in this case suggested that striking compression has been obtained, but in the upright film one was able to observe that the dilated bronchi had not been compressed at all.

CASE V. Female (M. A. G.), aged twenty-eight, first admitted to Barnes Hospital on November 13, 1929. The patient's chief complaints were hemoptysis, cough and mucopurulent expectoration. She attached importance to her symptoms only fifteen months previous to her admission. Her past history noted whooping cough at the age of five years, and considerable loss of time from school because of poor health which was manifested by weakness and with susceptibility to both head and chest colds. It is therefore not unlikely that the onset of the patient's condition dated back to childhood. Her tonsils and adenoids were removed when she was sixteen.

The physical examination including a lipiodol injection revealed left lower lobe bronchiectasis. The patient was therefore given postural drainage and pneumothorax treatment and at first made rather striking improvement. Her hemoptysis ceased. This pneumothorax treatment was continued at about ten day intervals. It was supplemented by a phrenicectomy, left, which was performed on April 25, 1929, by Dr. Graham. The diaphragm rose but little following this procedure. The patient still continued receiving pneumothoraces in amounts varying up to 500 c.c., the final pressures always being slightly negative.

This patient also suffered from nasal sinusitis and so her nasal sinuses were treated. Her right maxillary sinus was incised and drained on November 8, 1929; it contained a small amount of pus, the mucous membrane was thickened. Her left maxillary sinus was incised and drained on November 26, 1929; the findings were similar. A turbinectomy was performed on September 25, 1930, and her left ethmoid and sphenoidal sinuses were incised and drained on the same date. A small amount of pus was found. Here again the mucous membrane was thickened. All the aforementioned procedures improved the patient's cough and expectoration.

A satisfactory collapse of the left lung by pneumothorax treatment was obtained until January 2, 1930. Only 50 c.c. of air could then be injected before the pressure became positive. It was therefore decided to start oleothorax treatment. Twenty cubic centimeters of liquid paraffin were accordingly injected into the left pleural cavity on January 6, 1930, and 50 c.c. on the following day. Air was withdrawn before the paraffin was injected. Fluoroscopic examination at this time showed that the cavity was two-thirds filled with oil. An additional 25 c.c. were injected on January 8, 1930. The cavity now contained 95 c.c. of liquid paraffin and was over three-quarters filled. On January 10, 1930, the fluid shadow seemed to be larger; this increase in the amount of the fluid content was undoubtedly due to pleural reaction. The pulse and temperature curve remained unchanged. Oil was withdrawn at this time and was cultured; no growth was obtained. Thirty cubic centimeters of oil were injected on January 10, 1930, and 20 c.c. were injected on January 13 and January 17, 1930. Fifteen cubic centimeters were injected on February 5, 1930. The total amount of oil injected was therefore 180 c.c. The pocket was completely filled.

The patient has not received any refills for twenty months. She has gained in weight and her expectoration has been appreciably reduced since starting the oleothorax treatment. She has had only one attack of hemoptysis during the past two years. (See Fig. 4D.)

#### SUMMARY

Some experiences with oleothorax have been recorded. They concern its employment in the treatment of tuberculous

lesions of the lungs and pleura. Some examples of its value and limitations as a supplement to pneumothorax in the treatment of bronchiectasis have also been included. One case in which oleothorax was successfully employed to supplement an incomplete thoracoplasty for pulmonary tuberculosis, which had to be abandoned, because of a purulent pleural effusion on the affected and because of activity in the opposite lung is also reported. The foregoing and other unrecorded experiences justify our continued use of this form of treatment for purposes of compression and disinfection only in selected cases when other recognized methods fail. More and later observations are obviously necessary before the true value of oleothorax in any given type of case can be determined.

## BIBLIOGRAPHY

- ARMAND-DELILLE, P., and GIROU, J. L'oléothorax, complément du pneumothorax thérapeutique chez l'enfant. *Bull. Soc. de Pédiat. de Paris*, 28: 170, 1930.
- BAUMGARTEN, W. and RUSK, H. Personal communication.
- BERNOU, A. Contribution à l'étude des injections huileuses massive dans la plèvre. *Rev. de la Tbc.*, 7: 345, 1926.
- BRUNS. Ueber die praktische Bedeutung der Zirkulationsänderung durch einseitigen Lungenkollaps bei therapeutischen Eingriffen an der Lunge. *Beitr. Klin. Tbk.*, 29: H. 2, 253, 1913.
- BURNAND, R. Guérison d'une perforation bronchopleurale large dans un pneumothorax artificiel par la thoracoplastie combiné avec l'oléothorax. *Bull. et mém. Soc. méd. hôp. de Paris*, 41: No. 20, 871, 1925.
- CERUTI, G. Variazioni del ricambio respiratorio in seguito al pneumothorace e all'oleothorace sperimentale. *Arch. di fisiol.*, 29: 145, 1930.
- CHANDLER, F. G., and GLOYNE, S. R. Oleothorax. *Tubercle*, 8: 563, 1927.
- DUFALT, P. Oleothorax. *Am. Rev. Tbc.*, 23: 683, 1931.
- DIEHL, K. Die physikalischen und physiologischen Grundlagen des Oleothorax und ihre Folgerungen für die Klinik. *Ztschr. f. Tbk.*, 53: 514, 1929.
- Doppelseitiger Pneumothorax und Oleothorax und ihre Technik. *Beitr. Klin. Tbk.*, 68: H. 1, 173, 1928.
- FISCHER, B. Ueber experimentelle Erzeugung von Epithelwucherung und Epithelmetaplasie. *Verh. d. Deutsch. path. Gesellsch.*, 10: 20, 1906.
- Ueber experimentelle Erzeugung Grosser Flimmerepithelblasen der Lunge. *Frankf. Ztschr. f. Pathol.*, 27: 98, 1922.
- FONTAINE, J. L'oléothorax. Paris, Gaston, Doin, 1929.
- Statistics in 100 cases of oleothorax. *Rev. de la Tuberc.*, 9: 769, 1928. Abs.: *Am. Rev. Tbc.*, 22: 157, 1930.
- GILBERT, M. Oleothorax. *Tubercle*, 11: 385, 1930.
- HENIUS, K. Der Einfluss der Pneumothoraxbehandlung auf das Lungengewebe des gesunden und tuberkulosekranken Kaninchens. Ein Vergleich mit den Ergebnissen der Pneumothoraxbehandlung am Menschen. *Beitr. Klin. Tbk.*, 66: H. 5, 604, 1927.
- KUSS, G. Les indications essentielles de l'oléothorax dans la pratique du pneumothorax artificiel. *Bull. de l'acad. de Méd.*, 94: No. 36, 1002, 1925.
- KAUFMANN, K. Ueber die Veränderungen der Pleura und Lunge gesunden Hunde durch kunstlichen Pneumothorax. *Beitr. Klin. Tbk.*, 23: H. 2, 37, 1912.
- KOGAN, L. Ein Fall der Bronchialfistelbildung nach dem Oleothorax. *Ztschr. f. Tbk.*, 61: H. 1, 19, 1931.
- LOWENTHAL, M. Klinische Erfahrungen mit Oleothorax. *Beitr. z. Tbk.*, 72: 575, 1929.
- LABESSE, PAUL, et JULIEN CH. MARIE. De la place que doit tener l'oléothorax dans la collepsthérapie de la tuberculose pulmonaire. *Rev. Tbc.*, 2: No. 6, 648, 1930.
- LENORMANT and RAVAU, P. Tumors induced by subcutaneous injections of mineral oils. *Ann. Dermat. et Syph.*, 7: 601, 1926.
- MAENDL, H. Methods and indications for application and therapeutic value of oleothorax. *Wien. klin. Wchnschr.*, 43: 1252, 1930. Complete Bibliography.
- MORIN, J., et BOUESSEE, F. A propos de l'oléothorax. *Ann. de Méd.*, 25: 330, 1929.
- MORO, R. L'oléothorace nella cura della tubercolosi pleurica e polmonare. Abs. *Ztschr. f. Tbk.*, 61: H. 1, 72, 1931.
- OPPENGAME, L. E. Oleothorax. *Am. Rev. Tbc.*, 23: 673, 1931.
- ROSS, G. A., and TULLOCH, W. J. Further observations upon tuberculosis inoculata of the guinea pig. *Tubercle*, 7: 265; 321, 1926.
- SILLIG, C., and LANG, M. C. Oleothorax: Value of intrapleural injections of olive oil in certain phases. *Am. Rev. Tbc.*, 22: 725, 1930.
- THOMSEN. Ein neuer apparat für die oleothoraxtherapie als Ergänzung zur Pneumothoraxapparatur. *Beitr. Klin. Tbk.*, 75: 491, 1930.
- TULLOCH, W. J. A preliminary report of experimental immunisation against tuberculosis in the guinea pig by the use of "Oleo-vaccine." *Tubercle*, 7: 218, 1926.
- TOMASZEWSKI. Histologische Veränderungen der normalen und mit Tuberkulose infizierten Lunge unter dem Einfluss des Künstlichen Pneumothorax. *Beitr. Klin. Tbk.*, 36: H. 1, 1, 1916.
- WAITZ, C. Experimentelles zum Oleothorax. *Beitr. Klin. Tuberk.*, 73: 59, 1929.
- WALTUCH, E. Zur Indikation und Technik des Oleothorax. *Ztschr. f. Tbk.*, 60: 144, 1931.
- WINKLER, A. Ueber plastische Pleuritis bei Künstlichen Pneumothorax. *Beitr. Klin. Tbk.*, 54: H. 4, 335, 1923.
- YOUNG, J. S. The experimental production of metaplasia and hyperplasia in the serosal endothelium and of hyperplasia in the alveolar epithelium of the lung of the rabbit. *J. Path. & Bact.*, 31: 265, 1928.
- Further experiments on the production of hyperplasia in the alveolar epithelium of the lung of the rabbit. *J. Path. & Bact.*, 31: 705, 1928.

# ROENTGENOLOGIC DEMONSTRATION OF AN ANOMALOUS PROLONGATION OF THE ESOPHAGUS BELOW THE DIAPHRAGM, FACILITATING TOTAL GASTRECTOMY<sup>\*</sup>

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IN this case there was anomalous elongation of the subdiaphragmatic portion of the esophagus with a extent and situation of the growth. In general, carcinomas restricted to the pyloric half of the stomach are resectable, whereas



FIG. 1. With patient erect, prolongation of esophagus and correspondingly low point of insertion into stomach are seen. Upper level of barium in stomach is far above plane of esophageal aperture. This should be compared with Fig. 2.



FIG. 2. Normal stomach, with normal insertion of esophagus. Upper surface of barium is at level of esophageal opening.

correspondingly low point of insertion into the stomach, which facilitated total gastrectomy for gastric carcinoma. The case illustrates the value of roentgenologic examination in determining operability of malignant growths of the stomach.

Since partial gastrectomy is by far the most common radical operation for carcinoma of the stomach, the operability of a given case, so far as this can be determined by roentgenologic examination of the stomach, hinges primarily on the

those which are situated in the cardiac half, or which have invaded it from below, cannot readily be excised. This generalization, however, is subject to modification by other roentgenologically apparent factors, such as the character of the carcinoma, the degree of gastric mobility, and the width of the epigastric angle. Fixation of the stomach indicates that the carcinoma has invaded structures adjoining the stomach or has given rise to adhesions, and that resection will be difficult or futile. A wide epigastric angle favors surgical

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access to the upper half of the stomach and may permit resection of a carcinoma which has extended into this region. Scirrhus carcinomas infiltrate the gastric wall considerably beyond the limits of the roentgenologic defect, whereas the extent of medullary carcinomas corresponds closely to that depicted by the roentgen ray. However favorable the foregoing elements may be, metastasis or the general condition of the patient may forbid operation.

Many of the factors enumerated apply, of course, to total gastrectomy. It is essential that metastasis be excluded and that the patient be not unduly weakened, and free mobility of the stomach is scarcely less important. The infiltrative scirrhus carcinoma of low malignancy, which is typified in fibromatosis, or leather-bottle stomach, has little tendency to metastasis, does not usually fix the stomach by adhesions or extrinsic invasion, and is slow to impair the general state of the patient. Accordingly, total gastrectomy is more often feasible in this variety of gastric carcinoma than in other forms of equal extent. Seldom, however, is total gastrectomy facilitated by elongation of the subdiaphragmatic portion of the esophagus.

A woman, aged forty-four years, came to the clinic March 27, 1931. She had been in good health until June, 1930, when she had begun to have a feeling of intrathoracic pressure which was relieved by belching. Two weeks later she had commenced to experience nausea and vomiting about two hours after meals. Blood was not observed in the vomitus. For a few months she had been able to retain liquids, but solids induced vomiting. In this period she had lost 40 lb. in weight and became jaundiced, but she had not had colic referable to the gall bladder. In August, she had noted difficulty in swallowing solids. In October, cholecystectomy had been performed in her home city, when it was found that the gall bladder was full of stones. The surgeon also had found the gastric wall was "very thick and rubber-like," but had decided that further operation was not feasible at that time. For a week or two after operation her condition improved, and she had been able to take solid food. Then vomiting had recurred, often immediately after taking either solids or fluids,

and the loss of weight had continued. Examination at the clinic March 27 disclosed a palpable mass lying transversely in the epigastric region. The concentration of hemoglobin was 75 per cent and the Wassermann test was negative.

On roentgenologic examination, March 28, the distal two-thirds or more of the stomach was seen to be concentrically narrowed in the manner typical of scirrhus carcinoma. Even more striking than the lesion was the marked extension of the esophagus below the diaphragm, and its low insertion into the stomach, with the result that the upper level of the gastric content was well above the plane of the esophageal aperture (Figs. 1 and 2). Ordinarily the case would have been rated as inoperable, but in view of the esophageal prolongation, conditions seemed to be ideal for total gastrectomy, and this opinion was recorded in the report.

March 30, 1931, surgical exploration, by Balfour, through a left rectus incision, revealed carcinoma, typical of linitis plastica, involving the entire stomach. The esophagus was prolonged for about 2 in. below the diaphragm. At the pyloric end, the duodenum was fixed and the surrounding tissues were infiltrated, so that direct anastomosis of the esophagus with the duodenum could not be made. There was also some involvement of the mesocolon and a good deal of torsion. Therefore it seemed best to perform total gastrectomy, and make an end-to-end anastomosis between the esophagus and the jejunum, 14 in. (35.48 cm.) from the angle of the duodenum and jejunum. To this was added entero-anastomosis; also, jejunostomy for feeding. Evidence of metastasis was not found.

The pathologist examined the entire stomach and 1 cm. of the duodenum and found diffuse carcinoma, graded 3, of the linitis type, involving practically all of the stomach, with invasion of the serosa but without discoverable metastasis in the lymph nodes.

Two months after operation the patient was dismissed. At this time she had gained 3 lb.

The elongation of the esophagus in this case might plausibly be attributed to compensatory dilatation of the cardia and consequent traction on the gullet. However, such sequence has not previously been observed among the large number of patients with gastric carcinoma seen at the clinic, and it seems more probable that the anomaly was congenital.



# THE RÔLE PLAYED BY SPINAL NERVES IN FUNCTIONAL DISTURBANCES OF DIGESTION\*

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CLINICIANS in examining patients for disturbances of digestion and finding areas of hyperalgesia and tenderness in the abdominal wall are inclined to attribute these areas to disease of underlying viscera. In acute inflammatory diseases of intra-abdominal viscera, such areas of hyperalgesia and tenderness are supposed to be produced in the abdominal wall by reflexes originating in diseased viscera supplied by the same spinal segment as the hyperalgesic area in question. Irrespective of the mechanism involved in the production of abdominal wall reflexes in acute inflammatory visceral disease, it is altogether improbable that such reflexes are ever produced in functional and chronic diseases of intra-abdominal viscera. If extensive and exhaustive clinical investigation fails to disclose any organic disease of the viscus or viscera which the hypersensitive area of the abdominal wall indicates is affected, then some other explanation must be sought for the cause of the digestive mal-function from which the patient seeks relief.

Intercostal neuralgia has long been known to be capable of producing pain along the course of the intercostal nerves of the chest wall, but its importance in the production of pain and tenderness in the abdominal wall was perhaps first emphasized by Carnett<sup>1</sup> in 1926. His conclusions seem logical when we consider that the abdominal wall receives its innervation from the lower seven intercostals, the ilioinguinal and iliohypogastric branches of the first lumbar nerves. It would also seem logical to suppose that irritation or stimulation along the course of any of

these nerves would manifest itself by pain and tenderness, or a disturbance of tonus in the muscles and skin innervated by them.

Many clinicians have accepted the theories of Head, McKenzie, Lange and others who regard the sensory and motor phenomena of the abdominal wall as manifestations of intra-abdominal visceral disease reaching the abdominal wall through viscerosensory or visceromotor reflexes. They ascribe all areas of hyperalgesia and tenderness of the abdominal wall to afferent impulses from a diseased viscus reaching a spinal cord segment corresponding to the sensory innervation of the hyperalgesic area in question. Their theory does not go unchallenged, however, as Ryle<sup>2</sup> believes that non-inflammatory visceral lesions rarely give rise to referred pain or somatic hyperalgesia, and that referred pain is less prevalent in visceral disease than current clinical conceptions seem to indicate. Carnett<sup>3</sup> believes that the viscerosensory theory cannot be made to work out in actual practice. Robertson<sup>4</sup> speaking of rigidity states that defining it as a visceromotor reflex is almost certainly incorrect. Extensive clinical investigation, which after all, is a study of function, is perhaps the only way by which the truth or falsity of the Head-McKenzie theory can be properly evaluated.

The too ready acceptance of the Head-McKenzie theory by clinicians has perhaps blinded them to the fact that while the theory may be theoretically possible in certain inflammatory visceral diseases or visceral crises it cannot be made to apply to chronic and functional visceral disease. While volumes have been written upon

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functional disturbances but little has been written concerning the effect of somatic or peripheral influences upon abdominal viscera. The effects of emotional disturbances upon digestion have been studied and are fairly well understood. It is altogether probable that too many mal-functions of digestion are too readily classified as neuroses or emotional digestive disturbances, vagotonia, and many others when, perhaps, a more thorough clinical investigation would make a more definite classification possible.

Regardless of divergent views concerning the clinical application of the Head-McKenzie theory of visceromotor and viscerosensory reflexes, recent investigations by Freude and Ruhmann<sup>3</sup> apparently demonstrate that a reflex can occur in the opposite direction affecting changes in visceral organs through cutaneo-visceral reflexes. They studied the effect of thermal stimulation of the epigastrium through the fluoroscope and found that such stimulation elicited a response in the stomach in a few seconds. In general, they found that cold inhibited and heat increased gastric motility. If the stomach was hypertonic it was aggravated by cold and alleviated by hot applications. Ruhmann<sup>5</sup> has shown that similar visceral reactions can be obtained by chemical and mechanical means. In addition to the changes in motility noted it has been found that the visceral organ observed undergoes the same vasomotor change as takes place in the skin, i.e., cutaneous hyperemia causes hyperemia and cutaneous ischemia results in ischemia of the visceral organ. MacLeod<sup>6</sup> believes that reflex changes in the viscera may be set up through efferent pathways in the autonomic nervous system, but originating from stimuli acting on the surface of the body.

In general it may be said that the viscera of the abdomen have a double and antagonistic innervation through the autonomic nervous system. In order that a common terminology may be used throughout this paper and that conflicting terms, such as

sympathetic and parasympathetic nervous systems, may not be employed, the autonomic nervous system will be divided into the cranial autonomic nervous system whose preganglionic fibers lie chiefly in the vagus, but also in the third, seventh, ninth and eleventh cranial nerves; and the sacral autonomic nervous system whose preganglionic fibers emerge from the cord with the second, third and fourth sacral nerves. The cranial and sacral autonomic nervous systems comprise the bulbosacral outflow of the autonomic nervous system (sometimes called the parasympathetic division of the autonomic nervous system). The cranial and sacral divisions have a common function and will be considered together as the bulbosacral outflow. The thoracolumbar outflow on the other hand is comprised of preganglionic fibers which emerge from the cord between the first thoracic and the second and third lumbar segments. (This is sometimes called the sympathetic division of the autonomic nervous system.)

The function of the bulbosacral outflow, with the exception of the iliocolic and internal anal sphincters, is excitatory. It consequently favors the movement of food along the digestive canal and promotes the secretion of digestive fluids of the pancreas and salivary glands. The thoracolumbar outflow, on the other hand, diminishes the activity of the musculature of the gastrointestinal organs and the secretory functions of the glands of digestion, and tends to close the sphincters of the lower intestinal tract. Sensory, motor and secretory functions of visceral organs are almost entirely dependent upon the maintenance of a fine balance between the excitatory and inhibitory impulses reaching the viscera. Eppinger and Hess<sup>1</sup> recognized the fact that the bulbosacral and thoracolumbar outflows are tonically stimulated and maintain a physiological balance which may be shifted in favor of either system. Kuntz<sup>8</sup> does not believe that hypertonus of either the bulbosacral or the thoracolumbar outflows occurs

commonly, but he is of the opinion that such a conception offers an intelligent explanation of not a few phenomena occurring in functional visceral disorders.

From this evidence it would seem logical to assume that reflexes do occur from the somatic to the visceral zone, and that irritation or stimulation applied along the course of a spinal nerve or group of spinal nerves would be manifested by a disturbance of function of the viscera located within that particular reflex arc. That this is true clinically is manifested by the association of hyperalgesia of the abdominal wall with functional disturbances of digestion. Clinicians almost universally associate hyperalgesia of the abdominal wall with acute, subacute or chronic diseases of the viscera. If the area of hyperalgesia or tenderness is located in the right lower quadrant and is accompanied by complaints of disturbances of digestion, the cause of both the hyperalgesia and disturbances of digestion is thought to be chronic appendicitis. If the area of hyperalgesia is found in the epigastrium, on both sides of the midline, and is associated with disturbances of digestion the cause of both is thought to be either gastric or duodenal ulcer. If the area of tenderness is found in the hypochondrium to the right of the midline, the cause of the digestive disturbances and the tenderness is mistakenly thought to be a diseased condition of the gall bladder. To determine the exact location of hyperalgesia or tenderness elicited by palpitation of the abdominal wall, we must use some method by which it can be accurately determined whether the hyperalgesia is located within the structures comprising the abdominal wall itself, or located in an intra-abdominal viscus.

In 1926, Carnett<sup>1</sup> described tests by which hyperalgesia of the abdominal wall and tenderness along the course of the intercostal nerves could be accurately isolated from hyperalgesia or tenderness of intra-abdominal viscera which lie beneath the same area. These tests are

simple of application and once understood will serve effectually to differentiate abdominal wall pathology from intra-abdominal pathology. Carnett describes seven tests, the first of which is most important, the other six supplementing the first under certain conditions.

Test No. 1. By deep pressure. This test is divided into two stages (A) and (B).

(A). The confidence of the patient and his muscles is first obtained and then by the usual methods of palpation the fingers dip deeply into abdomen before pain is elicited, irrespective of whether the tenderness is parietal or intra-abdominal.

(B). The examiner keeps his fingers on the most sensitive area he has discovered and instructs the patient to make the abdominal muscles tense by making the diaphragm rigid, or raising the head, or raising the legs from the table without bending the knees. As the patient tenses his muscles, the examiner relaxes his finger pressure allowing his fingers to rise out of the abdomen; and then with the abdominal muscles tense he reapplies the pressure with the finger tips. If the area of tenderness is one of intra-abdominal tenderness only, the pressure applied to the tense muscles will fail to elicit any tenderness. If the case is one of parietal tenderness the complaint of pain will be the same or intensified.

Test No. 2. By pinch test. Pinching the skin and subcutaneous fat between the examiner's fingers. This is perhaps the best test for ascertaining the approximate area of tenderness. This test however may be negative in a small percentage of cases in which test B is positive due to all the parietal tenderness being located in the muscles. This test may also be performed in the lower right or left quadrant by pressing the skin and subcutaneous fat against the inner side of the iliac spine.

Test No. 3. By superficial skin tests. Hyperesthesia of the skin is revealed by pricking with a pin or stroking with a wisp

of cotton, or by the application of heat or cold.

Test No. 4. By pressure on nerve trunks. Tenderness will be found along the course of the nerve trunks supplying the tender area. If any doubt should remain in the mind of the examiner as to the authenticity of the findings of Test No. 1, the coexistence of nerve trunk tenderness, along the trunks of nerves supplying the tender area, should convince him that the tenderness found is in the abdominal wall and not within the abdomen. This association of nerve trunk tenderness with tender abdominal areas has apparently been overlooked by the writers upon viscerosensory reflexes.

Test No. 5. By pinching flank muscles. In certain thin individuals it is possible to demonstrate tenderness by picking up the skin, subcutaneous fat and superficial muscles layer in the iliocostal space.

Test No. 6. By pressure on transverse processes of vertebrae. Sometimes when tenderness is absent in skin and fat and muscles overlying the vertebrae and spinous processes deep pressure over the lateral processes will elicit tenderness.

Test No. 7. By pressure over remote areas. When the ilioinguinal nerves are involved, tenderness to pressure may be found for two fingersbreadth below and parallel to Poupart's ligament. When the last intercostal and first lumbar are involved there may be an area of tenderness over the buttock from the iliac crest to the level of a line drawn between the tips of the great trochanters.

By use of these tests it is possible to differentiate tenderness of the abdominal wall from tenderness of an intra-abdominal viscus. When it is found that the site of the tenderness elicited by examination is resident in the abdominal wall and not in the viscera the only logical conclusion is that there must be an irritative lesion of one or more of the intercostal nerves from which the abdominal wall receives its nerve supply. When we find associated with the areas of hyperalgesia or tenderness

complaints of digestive disturbances, and exhaustive clinical examination fails to find organic change in the abdominal viscera to account for such digestive disturbances it again seems logical to conclude that the functional digestive disturbances under consideration must be due to a periphero-visceral reflex.

It is a well known fact that hyperalgesia of the abdominal wall, accompanied as it often is by disturbances of digestion, has led to a great amount of unnecessary abdominal surgery as set forth by Carnett.<sup>9,10,11</sup> In addition to the large number in whom surgical intervention might be considered is a more numerous class of patients usually classified as neurotics, malingerers, liars and psychopaths. These make up the class who "sit and knit" and travel from physician to physician, always with hope in their faces but seldom reaching the goal of complete relief. The most usual accompaniment of hyperesthesia of the abdominal wall is tympanites, gaseous distension of the abdomen, eructations and sometimes vomiting after meals. The clinician's first reaction is that there must be visceral pathology but after roentgenological examinations of the gastrointestinal tract, the gall bladder, and the kidneys all prove negative, and the gastric analysis and stool examinations give no positive information the only logical conclusion possible is that there must be some connection between the hyperalgesia of the abdominal wall, the tenderness along the course of the intercostal nerves and the digestive disturbance under consideration. If, in addition to the negative clinical findings in intra-abdominal viscera we have definite pathology which can be demonstrated in one or more of the spinal nerves from which the abdominal wall receives its innervation it would seem but a logical conclusion that there exists a periphero-visceral reflex and that it is altogether improbable that the digestive mal-function is due to organic change in the viscera or due to a viscerosensory reflex.

## ILLUSTRATIVE CASES

CASE I. White, well-developed male laborer. Aged forty-nine.

In June 1929, while the patient was dropping box car with hand brake he was struck a violent blow on the lower left chest wall by brake stick. He was rendered breathless but resumed work for a short time. Examination one hour after injury disclosed a contused area over the ninth, tenth and eleventh ribs from the posterior axillary line backward to within 1 in. of the spine. Fracture of the ribs could not be found by either manual or x-ray examination. The abdomen was tender and slightly rigid. The lower chest wall was strapped as breathing was painful. The following morning at 4:00 A.M. the patient had great abdominal pain and distension. He stated that the chest injury was giving but little pain, but the abdomen felt as if it would burst. His abdomen was found to be greatly distended, acutely tender throughout, the tenderness was found to be parietal by the tests of Carnett, and tympanic upon percussion. Since we felt sure that there had been no visceral injury and that this was a case of adynamic ileus repeated pituitrin enemas were given with complete relief of the distentions. The abdominal rigidity remained for a period of one week, with no recurrence of the distention.

In this case it was at first thought that the cause of the ileus was traumatic temporary paralysis of the diaphragm. Recent investigations and clinical observations make it seem more probable that this was a periphero-visceral reflex originating in the traumatized areas of the ninth, tenth, and eleventh thoracic nerves. As in the course of any severe trauma, the initial symptoms may be less than they become subsequently, and the slow development of ileus in this case would seem to indicate that there was slow extravasation of blood along the course of the spinal nerves involved, gradually causing pressure sufficient to produce a periphero-visceral reflex of sufficient force that normal peristalsis was almost totally inhibited. It is a well known fact that ileus can and does result from trauma at a distance from the abdomen where

there is not brought into question injury to the abdominal wall or abdominal contents. Ileus occurring in this manner cannot be due to visceral injury. From the symptoms, clinical investigation, and subsequent course, ruling out the possibility of spinal cord injury, it seems logical to conclude that the ileus must be reflex in character, and as the trauma was at a distance from the abdominal wall or the abdominal contents, and was located in the periphery that it must be a periphero-visceral reflex.

CASE II. Short, rather obese female school teacher, forty-two years of age.

For the past eight or nine years she has suffered gaseous distension and eructations after meals. Is never entirely comfortable on account of feeling of fullness. Has tried various diets without relief. Three years ago she had her appendix removed on account of persistent pain in the right lower quadrant coupled with her digestive discomfort. One year later had a Webster-Baldy operation for a slight degree of retroversion of the uterus, lower abdominal and low back pain. She does not believe that either operation resulted in the slightest alleviation of her pain or discomfort.

*Examination:* Short obese female of cheerful disposition. Teeth were in poor repair with pyorrhea present. Tonsils septic and cryptic. Chest negative except chest wall which showed tenderness along the entire course of all spinal nerves below the fourth. The abdomen was so hyperesthetic that the slightest touch gave pain and deep pressure was impossible on account of pain. The information was volunteered that pressure over McBurney's point gave the same painful sensation as that elicited prior to her appendectomy. Practically the entire abdominal wall was hyperalgesic and tender. The previously described tests of Carnett in this case showed an increase in the intensity of the hyperalgesia with the muscles tense. The pinch tests were also positive and one could foretell from the area of abdominal wall tenderness at just which lateral processes of vertebrae deep pressure would result in complaints of pain. The abdomen was distended, and tympanitic throughout. Peristalsis was heard but was infrequent. Gastric analysis resulted in normal degrees of acidity and was otherwise negative. Urinalysis showed nothing

abnormal. Vaginal examination was negative. Slight spasticity of the colon was the only positive finding from gastrointestinal x-ray examination. X-ray examination of the spine showed exostoses with spur formation of the lower dorsal and upper lumbar regions. The bodies of the lower eight dorsal vertebrae disclosed lipping of the anterior adjacent borders. The upper and lower surfaces of the seventh and eighth dorsals were slightly irregular with some calcification of their intervertebral discs. The dorsal convexity of the spine was also exaggerated.

This patient was of the long suffering rather than the neurotic type. The abdominal wall was extremely hyperalgesic. The trunks of the intercostal nerves were tender throughout their course. The lateral processes were tender on deep pressure. The spinal x-ray examination disclosed exostoses, spur formation, lipping, body irregularity and other evidences of spinal arthritis. All of which is evidence of a widespread involvement of the spinal nerves from which the abdominal wall receives its innervation. Coupled with this evidence of spinal nerve involvement is a symptom complex of long continued digestive disturbance which exhaustive clinical investigation cannot account for on an organic basis, and which two operations and various recognized dietary and drug regimens have failed to influence in the slightest. The cause of the spinal nerve involvement is evident and the associated digestive disturbance in the face of negative organic change, can logically be explained by a periphoro-visceral reflex incited by arthritic changes in the spine causing an irritative lesion of the intercostal nerves. This is thought to be a true periphoro-visceral reflex, resulting in a functional disturbance of digestion.

CASE III. White female, sixty-five years of age.

Chief complaint gaseous distension of the abdomen and discomfort from fullness after meals. She sometimes has eructations and vomiting a short time after eating. Never true pain, but a feeling of distress and dis-

comfort. Condition has existed in spite of treatment by diets for the past five years.

*Examination:* Essentially negative except as related to the abdomen. The abdomen was distended, tympanitic and hyperalgesic throughout. The hyperalgesia was shown to be present in the abdominal wall and not in the abdominal viscera by Carnett's tests. Gastric analysis gave normal results. The gall bladder filled with the dye and emptied promptly. The urine was negative. Gastro-intestinal x-ray was negative. Spinal x-ray showed spur formation of the lateral edges of the lower dorsal and upper lumbar vertebrae. The anterior and adjacent edges of the dorsal vertebrae showed spurs throughout with bony bridging between the ninth and tenth vertebrae.

The hyperalgesia of the abdominal wall, and the distress from gaseous distension were both so pronounced that their close association was suspected before the positive findings of vertebral pathology, and the negative evidence of organic visceral change were known. The positive findings capable of producing the irritation of the spinal nerves shown, coupled with the negative gastrointestinal examination would apparently make a viscerosensory reflex explanation of the condition at least improbable and give weight to a periphoro-visceral reflex as a cause of the disturbance of digestive functions found.

CASE IV. Nurse, aged thirty-four. Well developed and well nourished.

Admitted with diagnosis of intestinal obstruction. She was of the neurotic type, apprehensive of the outcome of her condition and much discouraged. Temperature and pulse slightly elevated.

*Examination:* General examination negative until the abdomen was reached. The abdomen and history show scars of six previous operations. Abdomen tympanitic and distended. Hyperalgesia pronounced in all areas of the abdomen. Percussion or auscultation failed to show the loud boom of intestinal obstruction. Peristalsis was present but infrequent. Even when able to carry on with her work she suffered continuously from distress after meals, gaseous eructations and occasional vomiting after meals. She did not believe she had been benefitted by her previous operations. Hyper-

algnesia was shown by the Carnett tests to be present in the abdominal wall. The trunks of practically all of the spinal nerves were tender to pressure. The lateral processes were tender. The spine was definitely lordotic with some scoliosis to the left. The absence of violent peristalsis, the absence of hiccough and vomiting, and the fairly good appearance of the patient, coupled with the history of repeated operations without relief, and the extreme hyperalgesia of the abdominal wall out of proportion to the general condition of the patient, made laparotomy seem inadvisable. Repeated enemas, heat to the thoracic and abdominal wall, and the cautious use of pituitrin relieved the adynamic ileus which was evidently the cause of her condition. Barium meal the following morning did not aid in the diagnosis, showing but a slight spasticity of the colon.

Repeated operations here had not solved the problem of her digestive dysfunction. There can be no doubt that the hyperalgesic areas of the abdomen were mistaken as evidence of underlying visceral pathology. Had the simple tests of Carnett been used to demonstrate the fact that the tenderness was in the abdominal wall and not in intra-abdominal viscera many or all of the operations to which she had been subjected could have been avoided. She was of the neurotic type but the nature or purpose of the tests was not known to her, and she could not have accurately simulated the reactions to the tests. This is believed to have been a periphero-visceral reflex due to an irritative lesion along the course of the spinal nerves inaugurated perhaps by the scoliosis or lordosis and aggravated by a toxemia which had subsided and was not present

when examined. She was a transient and left the hospital before x-ray examination could be made of the spine.

### CONCLUSIONS

1. Hyperalgesia or hyperesthesia of the abdominal wall does not necessarily mean that the abdominal viscera are diseased.

2. Hyperalgesia of the abdominal wall may mean that the intercostal nerves are irritated or stimulated either at their point of emergence from the spine or at some point along their course.

3. It is important to differentiate as to whether the hyperalgesia lies in the abdominal wall itself or is due to tenderness of an abdominal viscus. The tests described by Carnett will effectually make this differentiation.

4. Recent physiological and neurological research give fairly conclusive evidence that there exists a cutaneo-visceral reflex. It is here believed that when the irritation or stimulation is applied to the deeper and larger spinal nerves it is manifested by digestive dysfunction due to a reflex transmitted from the periphery to the digestive tract through the autonomic nervous system. For want of a better name and to convey the idea desired, this is termed a periphero-visceral reflex.

5. By clinical investigation, affections of the spinal nerves, arthritis of the spine, injuries confined to the thoracic wall and fractures of the pelvis have all been found capable of producing minor functional disorders of digestion, or if the trauma or irritation is sufficient, they have been found capable of producing ileus.

### REFERENCES

1. CARNETT, J. B. Intercostal neuralgia as a cause of abdominal pain and tenderness. *Surg. Gynec. Obst.*, 42: 625, 1926.
2. RYLE, J. A. *Gastric Function in Health and Disease*. N. Y., Oxford Univ. Press, 1926.
3. CARNETT, J. B. The simulation of various intra-abdominal lesions by intercostal neuralgia of the abdominal wall. *M. J. & Rec.*, 129: 64-67; 1929.
4. ROBERTSON, G. Disturbed reflexes: Their significance in acute abdominal diseases. *Surg. Gynec. Obst.*, 43: 806, 1926.
5. RUHMANN, W. 1927. Quoted by Kuntz: *Autonomic Nervous System*. Phila., Lea and Febiger, 1929.
6. MACLEOD, J. J. R. N. *Physiology and Biochemistry in Modern Medicine*. St. Louis, C. V. Mosby Co., 1922.

[For remainder of References see p. 33]

# RADICAL OPERATION FOR CARCINOMA OF THE PENIS\*

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THOSE of us who are specially interested in the surgery of cancer are anxious to bring to the general profession the message of those who feel that radical surgery is the best method of treatment. We all know of the various methods that are advocated: there is x-ray and radium, and in the field of surgery we have various types of operations. If we are going to use surgery for the treatment of cancer we have to use it according to cancer surgery technique; if we are going to operate, we must do it thoroughly and completely in the first operation. If we cannot eradicate it in the first operation we may be sure we cannot do it in the second or third. Many of us feel that surgery is better than radium or x-ray. In many instances the two latter have given excellent results, but I do not wish to speak of those here but rather of surgery.

Cancer surgery should be standardized so far as the operation is concerned, and we should find out the best method to use if we are going to operate. In order to do that, we must first learn what the cancer field is, the primary lesion and where the cells can go. In the majority of cases they go through the lymphatic vessels to the regional lymph nodes, or they may pass through the perilymph-node spaces and go on to the more distant lymph nodes where they will be held up and develop into secondary metastases. Therefore, if we are going to do the operation thoroughly we must do it completely and remove the entire cancer field at one operation no matter how long the operation may take.

The patient presented is a man who had a lesion of the penis which began one year before admission to the hospital. He did nothing for this lesion, and finally when some urinary symptoms developed in the form of pain on voiding, he entered the New York Skin and Cancer Hospital in January, 1929. He presented a nasty, foul, ulcerating carcinoma of the end of the penis. Bilateral inguinal lymph nodes were palpable and also femoral nodes. His Wassermann reaction was negative. He was fifty-seven years of age.

Radical operation with total removal of the penis and a bilateral inguinal and femoral lymph node dissection were advised and consented to. On January 8, 1929, under 5 oz. of ether-oil colonic anesthesia, he was operated on and the entire penis with the surrounding skin at the base and the fat tissue including the lymphatic structures of both inguinal and femoral regions, and the adventitious tissue within the inguinal canal were removed in one block. The divided urethra was implanted in the base of the scrotum so that the patient could stand up while voiding and hold the scrotum to direct the stream.

The pathological report showed the tumor to be a prickle cell epithelioma with poor differentiation, Grade B, and the lymph nodes of both sides were hyperplastic.

It is now two years and three months since the operation and the patient is doing nicely and is free of clinical evidence of malignant disease.

The operative technique was carefully followed along the definite principles of cancer surgery technique, as laid down by Dr. George H. Semken. The plan of operation holds good for all cancer operations in any part of the human body.

\* Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, April 15, 1931.





# CARCINOMA OF THE BREAST\*

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THE present treatment of carcinoma of the breast began with the introduction of the radical operation.

In 1867 Moore of London recognized that in cancer the entire breast and surrounding tissue must be removed. The amount removed and the results of this treatment were not published.

In 1875 Volkmann stated that the fascia of the pectoral muscles may be infected and consequently removed it.

On April 20, 1894, Halsted read a paper describing his radical operation.

Seven months later, Nov. 12, 1894, Willy Meyer published a paper describing his operation. On these two methods the modern radical operation is based. The operation follows more nearly Willy Meyer's description, although the operation is often named after Halsted.

In a series of 7029 patients operated on before the introduction of the Halsted-Meyer operation, 29.2 per cent were alive and well at the end of three years. In 8921 patients operated on after the introduction of this operation, 43.2 per cent were alive and well at the end of three years, a gain due to the radical operation of 14 per cent. As nearly as I can estimate the results at the present time are little if any better than those made possible by the radical operation alone.

Since 1894, when the radical operation was introduced, there has been one important addition to our armamentarium, namely radiation. The value of this agent and its method of application are still to be evaluated.

Handley in England maintains that cancer spreads in four ways, first by infiltration of all contiguous tissue, second by permeation of the lymphatic vessels like the advancing edge of ringworm, third

by lymphatic emboli to neighboring lymph nodes and fourth by the blood stream. The last is probably of very minor importance. Handley thinks the permeation method is the most important and that the plane in which the permeation takes place is the deep fascia, thereby necessitating a very wide removal of this structure. Halsted agrees with Handley except in the plane of permeation, which Halsted considers to be the skin. If we accept Handley's plane, which is probably the correct one, local recurrences arise from cells beneath the skin.

There are two theories as to the effect of radiation. One is that cancer cells are killed more easily than tissue cells. Therefore the cancer cells are first destroyed. The other is that radiation produces an unfavorable soil for the growth of cancer by causing a fibrosis and endarteritis. So far is theory.

Experiment: Mice have been radiated in one groin, the other being protected. Implantation of transplantable mouse cancer into the skin of both groins will frequently fail to grow on the radiated side, but if the transplant is placed beneath the skin, the transplants take equally on both sides, showing an effect skin deep only.

Deductions: We know that many skin cancers and cancers of the cervix uteri are cured by radiation, therefore may it not be of benefit in cancer of the breast to destroy a residuum left by an operation. On the other hand, there is no authentic record of a cancer of the breast being cured by radiation alone; therefore it is unreasonable to expect it to kill deep cancer cells after the superficial ones have been removed with the knife.

Opinion: Trout and Peterson of Roanoke, Va., have a very good article on this

\* Read before the Hollywood Academy of Medicine, October 20, 1930.

subject in the Journal of American Medical Association of Nov. 1, 1930. As the result of a questionnaire they found that 89 per cent of surgeons and 91 per cent of radiologists assume that postoperative radiation is beneficial as an adjunct to the surgical treatment of cancer of the breast.

Facts: Clinical reports of cases of cancer of the breast so far have shown, by comparing results in cases radiated and not radiated, that radiation has no effect in preventing recurrences or increasing the percentage of five-year relief.

It is true that the early use of radiation, sufficiently long ago to give us five-year results is very different from that now used. Therefore we must have an open mind and give this phase of cancer of the breast intensive study.

In 1907 in an address before the American Surgical Association, Halsted stated, "It is especially true of cancers of the breast that the surgeon interested in furnishing the best statistics may in perfectly honorable ways provide them." Some surgeons will refuse to operate upon unfavorable cases and omit clearly hopeless cases, others will record all untraced cases as patients who have "died of cancer." The early writers figured on a three-year basis, the later ones on a five-year, etc. In 1926 Moschcowitz collected results from eight different clinics, the results showing as follows: alive and well at the end of five years 44.4 per cent, 38 per cent, 36.7 per cent, 34 per cent, 32 per cent, 27.7 per cent, 26.9 per cent, 26 per cent, a difference of 18 per cent. I do not believe that Primrose or Judd and Sistrunk who had the two highest percentages, recorded their cases in the same way as John B. Deaver, who had the lowest percentage.

In 1921 Greenough and Simmons, realizing the necessity for a uniform method of recording statistics, devised a system which has been adopted by the American College of Surgeons. This system has 24 items, each given a letter of the alphabet. By means

of formulae using these letters, their statistics are compiled. It may be noted that they separate primary from recurrent cases and that they reject all untraced cases and cases of patients dying of other diseases within the prescribed time limit.

Some things we know, some things we do not know about cancer of the breast, but only have opinions unsupported by facts. Our only progress in treating this disease will be by careful study and comparison of facts.

About eight years ago the American College of Surgeons undertook to study cancer through the Malignancy Committee of the Department of Clinical Research. In August 1929, they published their report on cancer of the breast. I will read some of their conclusions later. Last fall the College undertook to better the cancer service throughout the United States by the formation of cancer clinics. These clinics are to aid the physicians by studying the cases by a group of specialists instead of by individuals and also by keeping abreast of the latest developments in the treatment of cancer. The College will inspect and approve of such clinics in the same manner that it now inspects and approves hospitals. It will help them with advice concerning their cases and keep them informed of the cancer situation throughout the country. In return the cancer clinics are expected to aid in the fight against cancer by studying such cases carefully and submitting to the Committee in Chicago, case histories recorded in a uniform manner, from which accurate statistics can be obtained by an independent committee.

The Hollywood Hospital admits nearly 50 cases of cancer of the breast a year, a number too small from which to draw conclusions. But if each of the 61 hospitals throughout the United States which now have cancer committees would each send in say 50 records a year, the total would amount to over 3000 cases. This mass of case records would very soon produce statistics of immense value. The Holly-

wood Hospital now has a Malignancy Committee that is trying to fulfill the requirements of the College and help the physicians with advice as to the latest developments in the disease and help the fight against cancer by pooling its statistics with those of other committees. In order to do this, it is necessary to have the cooperation of every physician treating cancer.

The present-day status of cancer of the breast can best be summed up by reading a portion of the summary and conclusions by the Committee on the Treatment of Malignant Diseases with Radium and x-ray published in *Surgery, Gynecology and Obstetrics*, in August, 1929.

The study of 536 cases of cancer of the breast from 9 different hospitals in 1918, 1919, and 1920, recorded and classified in a uniform manner on a minimum five year end-result basis and supported by pathological evidence of the diagnosis of cancer, yields the following results:

Twenty per cent of all patients entering the hospital are alive and well at the end of five years after treatment.

Twenty-five per cent of all primary cases of patients are alive and well at the end of five years.

Twenty-eight per cent of the "operable" patients are alive and well at the end of five years.

The early favorable cases without axillary involvement give 57 per cent of successful results.

Of the patients entering the hospital with recurrence after operation only 3 per cent are alive and well.

No successful results were obtained without operative treatment.

In primary cases the best results (29 per cent) were obtained by the standard radical operation, with or without prophylactic x-ray.

In primary cases, x-ray alone gave no success.

The results of the standard radical operation with removal of both pectoral muscles (34 per cent) were superior to those in which the pectoralis minor was not removed (26 per cent).

The addition of preoperative or postoperative prophylactic x-ray treatment to the radical

operation gave no greater proportion of five year successful results.

Prophylactic x-ray did not prolong life in the unsuccessful cases.

Prophylactic x-ray did not diminish the incidence of local recurrence in the field of operation in unsuccessful cases.

There is no evidence in this series of cases to support the contention that prophylactic x-ray is of value as a supplement to operation in cases of cancer of the breast.

The value of x-ray in the treatment of recurrence after operation is established.

Advanced cases with remote metastases were little benefited by x-ray treatment.

The cases here reported were treated in the years 1918-1919 and 1920 at a time when radiation was not used as at present. The tendency of recent treatment is to use much heavier doses than formerly. Therefore, further statistics on this subject are necessary.

My own opinions are as follows:

1. Operable cancers of the breast should be subjected to the radical operation at the earliest feasible moment.

2. The radical operation should consist in a moderate removal of skin, a wide removal of fascia and the removal of both pectoral muscles and the axillary contents. I use a sharp scalpel.

3. Many patients having obviously inoperable cancers are more comfortable both physically and mentally if external evidences of cancer are removed, although they die of internal metastases.

4. All cases should receive postoperative radiation. After we have used all methods of treatment we know will do good, use also methods that may do good. Methods of radiation are improving each year. Statistics five years hence may be different from those just given.

5. Every physician seeing cancer cases should study the cases carefully, record their histories in the manner prescribed by the American College of Surgeons, so that each one may add his mite to the proper understanding of this disease. It is only by concerted action and pooling facts that we can progress.

# A CASE OF DIFFUSE SKELETAL METASTASIS

FOLLOWING RADICAL REMOVAL OF BOTH BREASTS\*

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THE most frequent metastatic occurrence associated with breast cancer is involvement of the skeletal system, and in a group of 100 cases so affected studied by them they have found but 6.

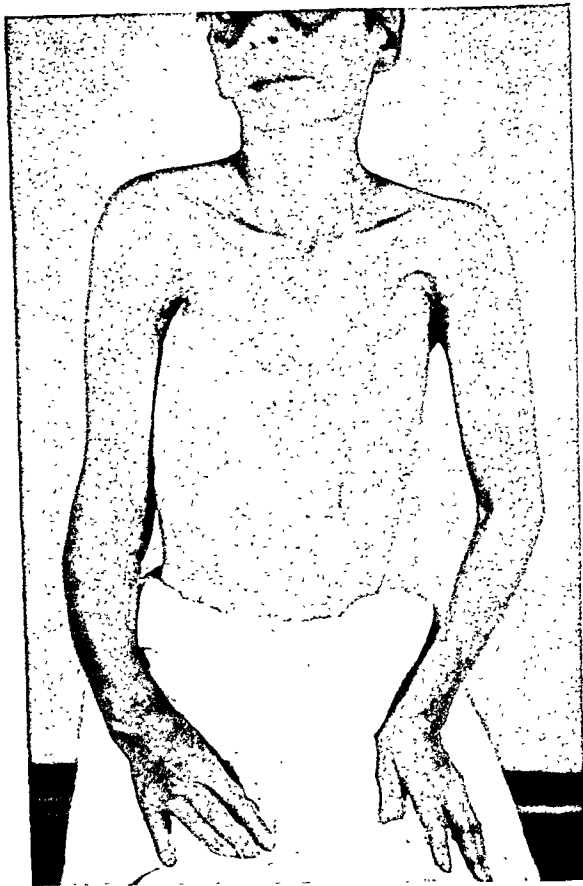


FIG. 1.

and that portion most often affected is the pelvis. The spine and femur are next in line and the ribs and skull are involved in about 30 per cent of all cases.

Metastatic involvement of the smaller bones is, according to Ewing, quite rare and very seldom is a metastatic lesion found in the radius and ulna. This infrequency, according to Carnett and Howell, is due to the fact that death usually occurs from extensive carcinoma before sufficient time has elapsed for the smaller bones to be reached by the malig-

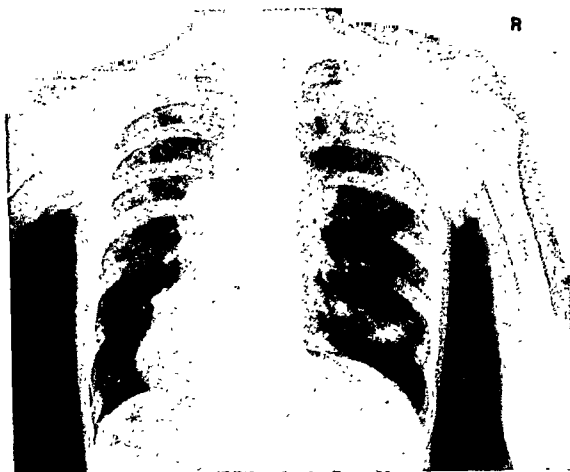


FIG. 2.

While primary carcinoma of both breasts is extremely uncommon, it is not an infrequent occurrence for cancer to be found in the second breast following removal of the first one for a malignancy. Often it is quite impossible to state definitely whether the involvement in the second breast is a primary, newly developing cancer or a secondary metastatic recurrence from the first lesion.

From our present knowledge of breast cancer it is impossible to eradicate the disease so completely by radical mastectomy that the patient can be assured against recurrences and more or less widespread metastasis. In our series of 249 cases, 1924 to 1930 inclusive, 17 had skeletal metastasis following radical mastectomy. In a series of 85 cases reported by Lenz and Freid, 66 per cent had skeletal metastasis following complete removal of a malignant breast. In Carnett and Howell's series of 204 cases 49.5 per cent showed bone metastasis.

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From the reports of various clinics and surgeons, as summarized by Pfahler, it does not seem to matter very much what

removal of tissues adjacent to the involved breast. In our observation of a great many cases that come to us in a late stage of car-

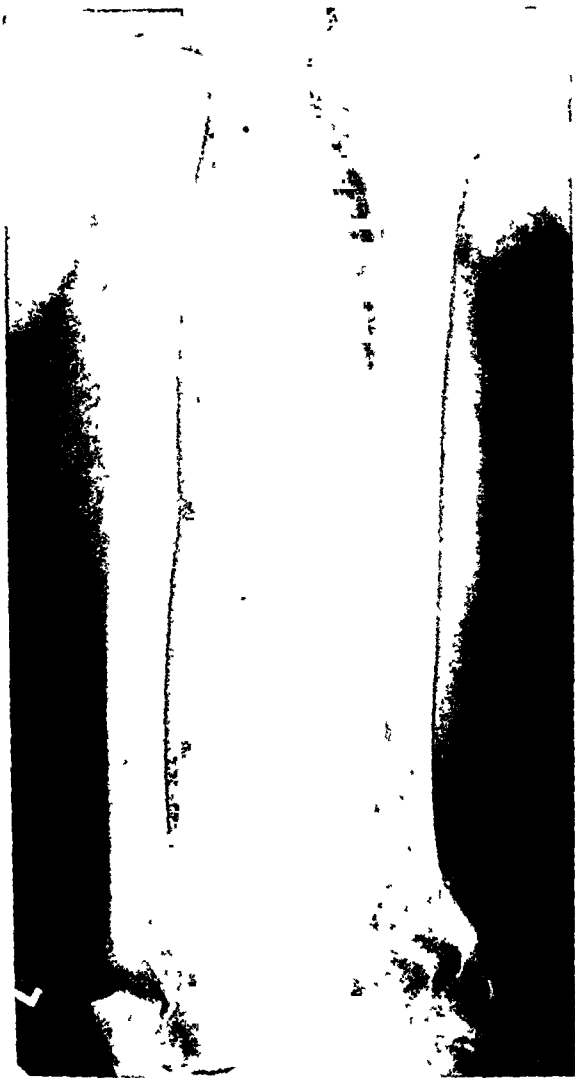


FIG. 3.

type of operation is performed in the removal of the breast, or whether the offending organ is removed by the usual surgical methods or by means of the various types of electrical cutting apparatus.

In his suggestion for the better control and eradication of cancer Halsted was the first to advocate widespread dissection of the breast and surrounding tissues, and Bull said that only a complete radical operation was of value in the treatment of carcinoma of the breast. Meyer and Semken have recommended an even more extensive



FIG. 4.

cinoma, we have noted widespread metastatic involvement in women for whom an extensive resection had been done; in fact one of the most extensively involved cases referred to the Cancer Hospital on Welfare Island in 1930 disclosed metastasis had even invaded the jaw bone, although this patient was operated upon by this extensive radical method.

Wyeth and other advocates of electro-surgical methods have stated that because of the electrical action on the tissues, the vascular and lymphatic drainage channels which, as far as our knowledge goes, are

the avenues by which malignancy spreads throughout the body, are sealed as they are cut. In this way supposedly the spread of metastasis is prevented. From our observations in the few we have done, we feel that the use of the electrical surgical knife offers no better or more real assurance against metastatic spread of carcinoma from a breast cancer than does the ordinary surgical scalpel. Evidently, therefore, it must be some other factor than a mechanical one which regulates the formation of metastasis following operation whether by the ordinary or the electrical scalpel.

Whether or not metastasis occurs more rapidly following operation is also a moot question.

The case herein reported is of interest because of the appearance of carcinoma in the left breast following complete radical removal of the right breast by endothermic surgery about two years previously and subsequent development of generalized skeletal metastasis leading to a fatal outcome about ten months later.

F. S., female, single, aged sixty-one. Always healthy until winter of 1926, when she accidentally noted a lump in the right breast. Roentgenography of the chest and skeleton by Dr. Gregory Cole in April, 1928, revealed no definite metastatic involvement of the skeleton, but a peculiar irregular production of new bone on the inner surface of the frontal bones. The right breast was amputated in April, 1928, with the high frequency endothermic knife, a complete radical mastectomy being done. In October, 1929, she noted in the left breast a lump which grew so large that in February, 1930, she was advised to have the breast removed. Again a complete radical mastectomy was done with the high frequency current. The pathological report of the tumor of both the first and the second breasts was carcinoma. The operative wound healed pres-

ently, but shortly thereafter the patient began to feel severe pains in the arm and right chest and some rheumatic symptoms in the legs and arms, and examination at that time April, 1930, showed no visible or palpable local metastatic foci. The patient received a course of high voltage x-ray therapy over the affected areas for a period of four weeks in April, 1930, then was not seen or heard from again until October, 1930, when she reported to the writer with a distorted right forearm, swellings on the skull and severe pains in the arms, legs and chest. She was extremely thin and wasted. Roentgenograms showed metastatic foci to the chest, head, shoulder and the right forearm. Of especial interest was the roentgenogram of the forearm, which showed a marked destruction of the radius and involvement of the ulna with severe and marked dissemination of the metastatic foci. She was referred to the hospital for palliative x-ray therapy and custodial care. The right forearm was splinted for relief of the fracture. For a time the patient was relieved of pain by x-ray therapy, treatments being administered to all the various metastatic foci discernible by roentgenograms or otherwise. But when on November 22, 1930 she expired in the custodial hospital, she was markedly riddled with bone metastasis, had a pathological fracture of one hip and was generally severely wasted. No post mortem was permitted.

**Conclusions:** Radical surgical removal of breast tumors does not prevent occurrence of metastasis to the skeleton.

High frequency current surgery alone offers no more assurance than ordinary scalpel surgery that metastasis will be prevented.

Delay in applying postoperative irradiation allows for metastatic dissemination.

The case herewith reported shows unusually rapid secondary recurrences despite radical electrical mastectomies and also an uncommon metastatic involvement of the bones of the forearm.

#### REFERENCES

- BULL, W. T. *Med. Rec.*, 46: 225, 1894.  
 CARNETT, J. B., and HOWELL, J. C. *Ann. Surg.*, 91: 811, 1930.  
 EWING, J. *Neoplastic Diseases*. Phila., Saunders, 1928.  
 HALSTED, W. S. *Ann. Surg.* 20: 497, 1894.  
 LENZ, M., and FREID, J. R. *Ann. Surg.*, 93: 278, 1931.  
 MEYER, W. *Med. Rec.*, 46: 746, 1894.  
 PFAHLER, G., and PARRY, L. D. *J. A. M. A.*, 4: 101, 1930.  
 SEMKEN, G. H. *Ann. Surg.*, 79: 461, 1924.  
 WYETH, G. A. *Ann. Surg.*, 79: 9, 1924.  
 WYETH, G. A. *Surgery of Neoplastic Diseases by Electrothermic Methods*. N. Y., Hoeber, 1926.

# PRESENT STATUS OF CANCER OF THE CERVIX AND UTERUS\*

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**F**ORTY per cent of the malignancies occurring in women are cancers of the cervix uteri; inasmuch as women are the subject of cancer to a greater degree than men, cancers of the cervix cause more than one-twentieth of 105,000 deaths from cancer each year. If it could be impressed upon the lay public, and more definitely appreciated and taught by the profession that cancer of the cervix in its incipency is a local disease which may be destroyed, eradicated, and cured, our propaganda for early diagnosis of carcinoma would be an easy matter. Cancer of the cervix for obvious reasons in its early stages is too often overlooked. No amount of instruction in regard to the early signs of cancer seems to remedy this unfortunate oversight.

Periodic and frequent pelvic examination, especially in every woman over thirty years old, should be advised and carried out at least once each year. Especially is this important in women who have borne children, as 95 per cent of cancers of the cervix arise from traumatized cervicies due to birth injuries plus latent and chronic infections. Pessimism in regard to the cure of cancer of the cervix on the part of the profession and the public should be transformed into an optimism in regard to its cure.

As borne out by recent statistical evidence of no less than eight prominent clinic centers, the percentage of five-year cures in early cancer of the cervix runs from 64 to 80 per cent.

If every woman could be convinced that cancer of the cervix at an early stage is curable, and then made to realize that a thorough pelvic examination once a year

by a competent physician will discover the early signs, our problems would be an easy one.

The specific cure or palliative treatment for this type of cancer lies in two fields: some form of surgery or some form of irradiation, and one or both of these forms of treatment apply to any stage of *cancer of the cervix*, and can either cure or materially modify the course and extend the life of the patient.

Every victim, either early or late, of cancer of the cervix should be furnished with either one or the other form of treatment, or both, as a permanent cure or a palliative measure.

The results in treatment of cancer of the cervix up to 1919-20 either by surgical means or radiology were admittedly unsatisfactory.

In estimating the value of any method of treatment, the first and most important question is the ultimate result, determined according to established practice on the survival ratio at five years.

Healey has recently drawn attention to the fact that recurrences especially of the retroperitoneal lymphatics recur as late as seven or eight years after the primary treatment and relative cure. However, all statistical records thus far obtained are worked out on a basis of absolute five-year cures. The attendant risks, the morbidity and late complications and treatment require consideration; also, on the other hand a palliative effect on the advanced cases which do not survive five years.

Surgery for cancer of the cervix was first brought to the attention of the profession in 1898 by Wertheim. This technique

\* Read before the Hollywood Academy of Medicine, Oct. 20, 1930.

has been followed to date with very little change, with, however, a primary mortality of 30 per cent having been dropped to a primary mortality in Weibel's last 500 cases, to 8 per cent. This improvement in primary mortality is thought to be due to better preoperative care and improved types of anesthesia and asepsis.

In the Shaute Clinic in Vienna, the primary mortality is at present 3.4 per cent, due probably to a better choice of patients, and due to the fact that they have a radium and cancer department in conjunction with their operative clinic, for treatment of late second, third and fourth degree cases. Weibel's low primary mortality is an exceedingly low figure for the average surgeon to aim for. One has but to observe the technique and time consumed by Weibel in doing the Wertheim operation to realize that his great series of over 1000 cases, have made him probably the master of this type of operation. The average primary mortality for Weibel's total series is 13.8 per cent against an average primary mortality in various radiological clinics of from 2.1 per cent to zero.

Against the primary mortality in surgery we have the late radium reaction cases, chiefly rectal, which occur in approximately 10 per cent of all cases as reported by Heyman, Chief of the Radium Hemmet in Stockholm.

In order to classify cancer of the cervix in relation to the extension of the disease, the group of Henry Schmitz of Chicago is the one generally used, especially in this country and in England.

First degree: Early operable. Growth limited to cervix.

Second degree: Border line. Cancer extends to the adjacent tissues in the vaginal vault, or there is beginning infiltration of one or both parametria, but without fixation.

Third degree: Inoperable. Invasion of the rectovaginal or vesicovaginal septum, infiltration of one or both parametria with fixation, or involvement of the uterosacral ligaments.

Fourth degree: Hopeless. Pelvic block, with, or without distant metastasis.

As a member of the Malignancy Committee of the Hollywood Hospital the past summer I visited 16 cancer centers in this country and Europe with the idea in view of better familiarizing myself with the more modern standardized methods of diagnosis and treatment of cancer of the cervix. In the short space of time allotted to me I will scan over the different methods which I was able to observe.

In the Cancer Hospital in London, the chief method of treatment is with radium followed by x-ray, using a modified Stockholm technique. Dosage to the average case is a total of 6700 mg. hours, using 2200 mg. hours in the uterus and 4500 mg. hours in the vagina. The technique is done in three applications: the second application is one week after the first, and the third application is three weeks after the second treatment. Routine treatment per application is 1500 mg. hours to the vagina, and 750 mg. hours to the uterus and cervix. Radium element is used throughout. The radium in the uterus and cervix is in tandem and to the vagina they use plaques. All radium treatments are furnished by the radium Sister in charge, and all treatments are placed by the gynecologist on service. In the Marie Curie Clinic in London, we have a hospital of 50 beds devoted exclusively to the treatment of cancer in women. Patients in this hospital being sent from the clinics of four hospitals:

The Royal Free Hospital

The South London Hospital

The Elizabeth Garratt Hospital, and

The New Sussex Hospital in Brighton.

The chief surgeon in this hospital is Dr. E. Hurdon who, with an advisory board of eight physicians, controls and advises the treatment of all cancer of the cervix and uterus given. The routine treatment as followed out in this hospital consists of 40 to 50 mg., of radium element in intra-uterine tubes, and vaginal applicators, two in number, each containing 25 mg. of



radium element. The vaginal applicators are placed in position and held there by a gauze pack soaked in  $\frac{1}{2000}$  acriflavine. Three treatments are given of twenty-two hours each, the second one week after the first, and the third two weeks after the second. Average doses are about 7000 mg. hours with a maximum dose not to exceed 8000. In from four to six weeks deep x-ray therapy is started.

In the Chelsea Hospital for Women, London, Sir Victor Bonney does his modification of the Wertheim technique on *all first and most all of the second degree* cervix cases coming on his service. Those cases of patients not operated on are treated in London Cancer Hospital, a few doors from the Chelsea Hospital. Victor Bonney has seen 450 cases of cancer of the cervix and has operated on 284 patients, with the radical Wertheim technique, with a relative cure of 38.7 per cent, and an absolute cure of 24.4 per cent, and has found 43 per cent of the glands involved. My observation of Victor Bonney's work is that he operates more advanced second degree cases than anyone except Weibel.

In Berlin, I had the privilege of observing Stoeckel and Wagner. Prof. Stoeckel has developed a special technique in which he uses preoperative radiation to the amount of 5000 to 6000 mg. hours to be followed in from ten days to three weeks by his modification of the Schaute vaginal hysterectomy. Following this, in six weeks, his patients receive deep x-ray therapy. Stoeckel has a relative curve of 50 per cent, and an absolute cure of 18 per cent. He makes a statement that radical surgery following radium is made easier than without preoperative radiation. Prof. Wagner of Berlin, uses the Wertheim operation almost exclusively in all first and some second degree cases.

In Prague, the large Prague Sanatorium has as the Chief Gynecologist, Dr. Ostreil. Ostreil informed me that he now operates in 10 per cent of the carcinoma of the cervix and uses radium and x-ray in 90

per cent. The technique of this clinic is slightly different from that of any other clinic visited, in that they inject a silver emulsion, called Wolfram, into each parametrium. They claim the ability of Wolfram to absorb radiation which is given off by the radium treatment, which emulsion in turn continues to throw off radiation for at least three weeks without necrosis. The total radiation is a minimum of 6000 mg. hours with a maximum of 8000. Prof. Weibel is the gynecologist in the Czeck University and has probably *performed more Wertheim operations than any other man today*. His technique is very radical in that he resects the glands in both sides in Station 1 and 2; the time consumed is usually about forty-five minutes. Weibel's relative cures are 38.4 per cent, using the Wertheim technique exclusively. His absolute cure is 19.2 per cent.

In Vienna, the Peham Clinic uses the Schaute operation on all first degree cases, and has in connection a radium department of 25 beds where all second, third, and fourth degree cases are treated. The Peham Clinic has a relative cure of 50 per cent, and a primary mortality on all operable cases of 3.4 per cent.

In Munich, Doederlein claims to be the first gynecologist in Europe to use radium and x-ray for carcinoma of the cervix. His work began in 1913 with a record of:

First degree—50 per cent cured  
Second degree—22.3 per cent cured  
Third degree—10.7 per cent cured  
Fourth degree—2.3 per cent cured.

These statistics are from 1913-23, including at least six years' observation on all cases, total number of cases treated, 1319. Percentage of cures for all cases, 28.2 per cent. Doederlein does not believe in the use of emanation, and advises the use of radium element, 100 mg., repeated in eight days. Total dosage 9000 to 12,000 mg. hours in the average case.

In the University of Zurich, Prof. Walthard was the first to use the systematic

pre-radiation to be followed by the radical Wertheim operation for this disease. Walthard claims that radium used preoperatively sterilizes the carcinoma, that the discharge decreases and often stops, and that streptococci previously found disappear, and as a result the primary operative mortality is markedly decreased. He has been able to drop his primary mortality, due to peritonitis from 10.9 per cent to 4.4 per cent.

In Berne, Prof. Guggisberg advises the modified Wertheim procedure for all first degree cervical cancers. All second, third, and fourth degree cases he treats with two applications of radium, first of 4000 mg. hours, second applications to be followed in eight to fourteen days with 3000 to 4000 mg. hours. For exceptional patients who react poorly to the first application, he holds off the second application for as long as thirty days. His advice is never to use over 10,000 mg. hours and he considers small doses of radium as *more dangerous* than none at all. He follows all operative and radium treatments with deep x-ray.

In Paris, I visited the Curie Foundation, with Prof. Regaud in charge, and Hartmann's Clinic in the Hospital Dieu. The technique in the Curie Foundation as followed by Regaud is somewhat different from any of the techniques heretofore mentioned. The intrauterine stem applicators contain three radium needles in tandem, the upper needle contains 6.66 mg., the other two needles contain 13.3 mg. Vaginal applications are placed in cork tampons connected by a steel spring resembling a clock spring, and called a Colpostat, giving a total radium application of 53 mg. which is left in continuously from five to seven days, all tubes and applicators being removed daily and replaced in position. The total dosage is from 6300 mg. hours to 9300 mg. hours, with an average of 7200 mg. hours per case. The number of intrauterine tubes may be varied depending on the length of the uterine canal. When the uterine canal

is blocked treatment is given twice, first in the vagina and after retrogression of the growth into the uterus. The first treatment with radium is always done under an anesthetic, and is followed in from twelve to twenty-one days by deep x-ray. The deep therapy x-ray is given four hours a day, two hours in the forenoon and two hours in the afternoon for 100 hours at a distance of 90 cm. using 200,000 volts. In a large series of cases in the Curie Foundation, Regaud has found a 5 per cent series of adenocarcinoma of the cervix, which is definitely resistant to radium, and for which he advises surgery as a method of choice.

In the Hartmann Clinic, the cervical malignancies are treated by Sophia Fabre. In the work in this Clinic, which has approximately 60 beds, they use the Regaud technique, with the exception that Madame Fabre has for twelve years been studying the effect of vaccines in the infected cervical carcinomata with the following conclusions: that there is always a gram-positive diplococcus present which they have not been able to identify, but from which they have been able to make a vaccine, which vaccine applied locally to the infected growth produces a reaction favorable to the patient and reduces radium reactions in these cases. She precedes all radium treatments of fungating carcinomas with an autogenous vaccine applied locally with apparently good results. These findings would seem to be in contrast with the generalized belief that the streptococcus is the offending organism in all ulcerating and fungating growths of the cervix.

In the Memorial Hospital, New York City, we have the largest Cancer Institute in the United States; the chief gynecologist is Dr. Wm. P. Healey, under whose direction all cervical carcinoma are treated. Routine treatment for carcinoma of the cervix is radium emanation in a stem applicator with an attached vaginal applicator if the vagina is involved, amount of radium dosage varying from 5 to 7000

mg. hours and either preceding or followed by deep x-ray. Drs. Healey and Cutler have recently shown evidence that cervical cancer can be classified, according to cell type, into 3 grades:

- Grade 1—the adult type
- Grade 2—the plexiform type
- Grade 3—the anaplastic type.

In their group of 200 cases presented:

- Grade 1 is 17 per cent
- Grade 2 is 62 per cent, and
- Grade 3 is 21 per cent

In this gradation shown by biopsy, the pathologist is able to more ably correlate from the radiosensitive and the radio-resistant tumors of the cervix. The pathologist on our committee has worked this gradation method for the past year and a half. Dr. Healey has a routine treatment in all infected or ulcerating carcinomata, giving five deep x-ray treatments in one week preliminary to insertion of radium. This treatment causes marked retrogression of the growth, and if there is still a growth in the vagina present he places the vaginal bomb to the growth with a dose of 1000 mg. hours to be followed in from one day to one week with a cervical applicator of 3000 mg. hours. He then waits for one month to apply his second radium treatment into the cervix.

In conclusion I will state that in all clinics visited, patients with cancer of the cervix were given preliminary preparation which included a careful vaginal examination plus a physical examination with care being used in the preoperative or preradium treatment of individual cases. All patients with a discharge were given the advantage of a rest of from two days to three weeks in bed, with time being given to establish a normal temperature and normal leucocyte count for at least seventy-two hours preceding any treatment. This can be effected by routine tonics plus antiseptic douches. In all clinics visited the care and treatment of these cases was under the direction of a

gynecologist trained in this type of work. In the administration of radium an anesthetic was always used for the first application of radium, and in half the cases second and third applications were given under anesthesia. The most gentle manipulation is necessary in the application of stem applicators and packing off to avoid radiation to bladder and rectum. The

		Num- ber Alive	Num- ber Dead
Total number of carcinoma of cervix.....	59	30	27
Total number of carcinoma of corpus.....	14	10	4
	73		
Cancer of cervix operated.....	20	13	3
Cancer of cervix radium and x-ray.....	33	14	16
Cancer of cervix, using surgery, radium, and x-ray.....	12	9	3
Cancer of cervix using other treatments.....	7		

	Number with Biopsy	Number with- out Biopsy
Cancer of cervix.....	29	32
Average number of mg. hours treated—	3200	
Dates		
1928—26		
1929—30		
1930—26 (ten months only).		
Ages		
25 to 30—	6	
31 to 40—	11	
41 to 50—	16	
51 to 60—	22	
61 to 70—	10	
71 to 80—	7	
Youngest Patient		Oldest Patient
Twenty-five years		Eighty years

routine operative and radium treatments throughout all clinics visited are more or less standardized and summed up, are as follows:

1. Surgery to include the Wertheim or Shaute technique only.
2. Radium to the amount of 6000 to 12,000 mg. hours with practically standardized filtration.
3. Wertheim or Shaute technique in conjunction with preoperative or post-operative radiation or x-ray.

4. All cancers of the cervix to be carefully examined and diagnosed as to the degree of the disease and to have a biopsy for classifying as to group.

5. All clinics now require a routine biopsy for pathological examination before any treatment is given.

6. All cases treated should be carefully checked up at regularly stated intervals both by the gynecologist and radiologist.

7. The primary surgical mortality now varies from 3.4 per cent to 8 per cent, and

the primary radium mortality varies from 2.7 per cent to zero.

8. To date the highest relative cures are reported through radium and x-ray treatment, while the highest absolute cures are reported through the use of surgery with preoperative or postoperative radiation.

A brief summary of the cases treated in the Hollywood Hospital, from Jan. 1, 1929 to Sept. 30, 1930 are as shown in tables on page 32.



#### REFERENCES OF DR MCDERMID.\*

- |   |   |
|---|---|
| <p>7. EPPINGER, H., and HESS, L.: 1909. Quoted by Kuntz: Autonomic Nervous System.</p> <p>8. KUNTZ, A. Autonomic Nervous System. Phila., Lea and Febiger, 1929.</p> <p>9. CARNETT, J. B. Neuralgia of the intercostal and first lumbar nerves. <i>Penn. M. J.</i>, 32: 876-880, 1929.</p> | <p>10. CARNETT, J. B. Simulation of gall-bladder disease by intercostal neuralgia of the abdominal wall. <i>Ann. Surg.</i>, 86: 747, 1927.</p> <p>11. CARNETT, J. B. Pain in the diagnosis of abdominal pathology. <i>Med. Bull. Lycoming Co. (Pa.) Med. Society</i>, June, 1929.</p> |
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\* Continued from p. 20.

# TOTAL VOLVULUS\*

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**T**OTAL volvulus connotes a torsion of the entire small intestine together with the cecum, ascending and trans-

small intestine with the umbilical loop and mesenteric attachments at about six weeks. The portion of the large intestine,

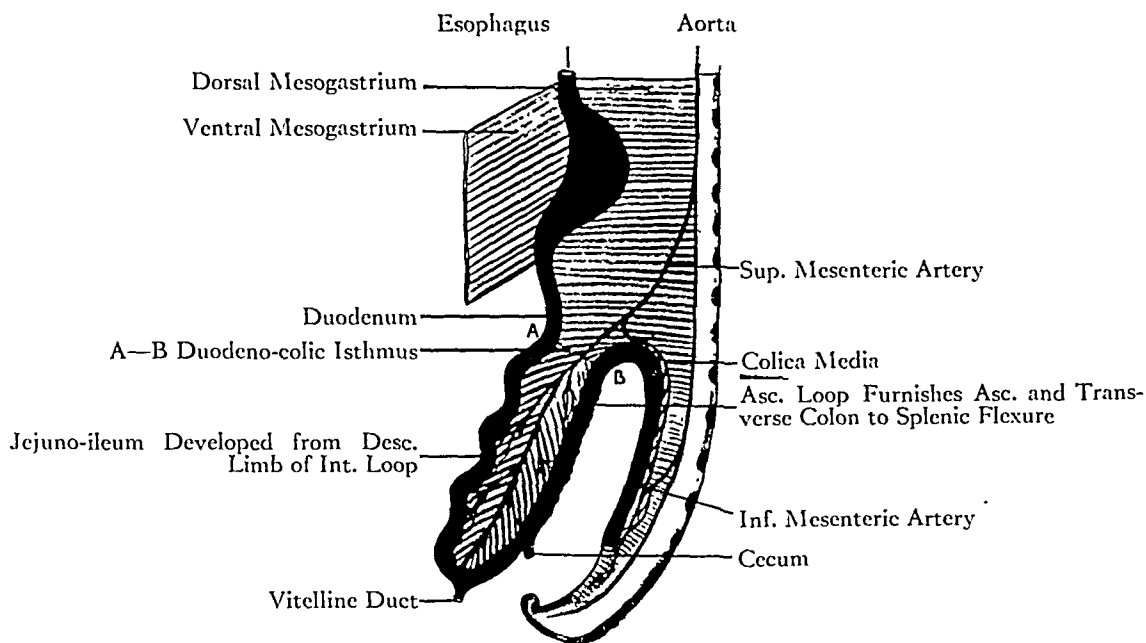


FIG. 1.

verse colon. The condition is rare and the relevant literature very scant. The 3 cases comprising this report occurred in two patients. The reoccurrence in patient R. Z. presented an opportunity for a more thorough appreciation of the pathology and emphasized the importance of appropriate treatment to prevent recurring torsion. It is the writer's purpose to review the literature to date and subscribe thereto 3 additional cases.

Failure or arrest of development at the primitive stage with consequent persistent embryonic conditions of the mesentery, makes possible total volvulus.

Figure 1 is the schema of the human embryonic intestinal canal of the large and

developed from the ascending limb of the loop, rotates, in the third month, to the middle line coming in contact with the ventral abdominal wall. From here the large intestine passes ventrad of the jejunoileal coils, towards the cephalic end of the abdominal cavity and lies transversely along the greater curvature of the stomach.

The rapidly growing coils of small gut, developing from the descending arm of the loop, crowd the colon more and more cephalad. In the fourth month the cecum turns to the right, coming into contact with the under surface of the liver, ventrad to the duodenum, and subsequently reaches the ventral surface of the right kidney.

\* Submitted for publication April 4, 1931.

Failure of the normal rotation and of the adhesion and fusion of the various visceral and parietal peritoneal layers results in the persistence of this embryonic stage of a free common mesentery to the duodenum, small intestine, cecum, ascending and transverse colon and permits of total volvulus through axial torsion about the duodenocolic isthmus.

The earliest case found in the literature is a report by Kuljabzo-Koreski in 1847 of a male twenty-two years old.

The patient complained since childhood of severe attacks of colic, vomiting and diarrhea. The last attack persisted five days before the patient was operated on. He died the day of operation. Autopsy findings showed mesenteric conditions corresponding to the fourth to fifth week of fetal life. The small intestine, cecum and ascending colon had made four complete torsions around the mesenteric radix, resulting in gangrene, perforation and general peritonitis.

In 1865 Valenta published a report of a male infant who died on the fifth day of intestinal obstruction and peritonitis. The pathological report is somewhat confusing. It is a dubious case of total volvulus. The author states that 26 similar cases were collected from a survey of the specific literature. These cannot be found.

In 1877 Theremin reported the case of a male infant, who died on the twenty-first day without operation. There was a double counter-clockwise rotation of the entire small intestine, cecum and ascending colon about a common fetal mesentery. The author states that he observed 2 other similar cases at the St. Petersburg Foundling Institute, which he does not report.

In 1878 Epstein and Soyka reported the case of a male infant, who died on the tenth day without operation.

The infant had continued unobstructed bowel movements, associated with vomiting of fecal material and upper abdominal distention. Post-mortem findings revealed the mesocolon not fixed to the posterior abdominal wall.

The ileum and colon made a half turn about the duodenocolic axis, displacing the cecum to the left groin.

In 1883 Bruhns reported the following case:

A strong well nourished man, aged twenty-four, who complained of progressive abdominal pain for five days, associated with one fecal vomit followed by persistent constipation. Similar milder attacks accompanied by fecal vomiting had occurred one, two and one-half, and ten years before, the patient enjoying perfect health in the intervals. Physical examination showed abdominal distention with some free abdominal fluid. Pulse 88; temperature 38°C. Belladonna medication and strict diet relieved the pain, but repeated enemata had no effect. Three days later abdominal distention and pain had so increased that laparotomy was done. The highly distended and hemorrhagic intestines were delivered. The small intestine, cecum and ascending colon were found to have made two complete clockwise rotations around the mesentery of the small intestine. Operation: Detorsion and 3 cm. incision in lower ileum to void gas and hemorrhagic fluid. Closure of abdomen. Death took place forty minutes postoperative. No autopsy.

In 1894 Obalinski reported a questionable case in a male of thirty-seven years. The volvulus was detorsioned with recovery.

In 1897 Key operated upon an adult male fourteen days after onset.

The condition was not recognized and a left colostomy was performed. The patient died the same day. Autopsy revealed one complete torsion about a common mesentery. The colon, as in the writer's cases, showed great distension. Its largest circumference measured 38 cm.

In 1898 Helmsmueller reported the case of a twenty year old man, who took a forceful jump, followed by immediate onset of severe abdominal pain associated with vomiting.

On admission to the hospital the patient had sudden severe collapse and pallor, weak frequent pulse, moderate abdominal distention with increasing dullness in lower abdomen and increasing meteorism. Death occurred five

hours after admission. Autopsy findings showed the right abdomen occupied by a tumor, which represented one complete clockwise torsion of the intestinal tract from the beginning of the jejunum to the transverse colon. Both ascending colon and small intestine were found markedly dilated and discolored. The abdominal cavity contained opaque hemorrhagic fluid and the small intestine a quantity of thin cloudy blood.

In 1899 Schreiber reported the case of a boy of nine years.

Since birth he had repeated attacks of colic, obstipation and vomiting. The present attack lasted five days and the patient died rather suddenly of shock. Autopsy revealed a common fetal mesentery, whose root was inserted near the third lumbar vertebra immediately above a horseshoe kidney. The cecum and ascending colon were twisted to the left around the mesenteric radix and represented the original volvulus around which the jejuno-ileum had made a second left torsion.

In 1900 Von Manheuffel reported a case under the title of volvulus cecii.

This occurred in a man, aged twenty-one years, who was operated upon the third day after the onset of obstruction. The patient died three days later. The description of the pathology is somewhat confusing. The operation consisted of detorsion and repositioning of the intestinal tract. The author states that the common duodenojejunal ileocecal mesentery found corresponds to an earlier fetal phase than Gruber's mesenteric mesocolonic ligament.

In 1901 Froelich reported a unique case in a boy of three years, in whom the torsion included the small intestine and the entire colon. Broca states this is the first case on record in which the entire colon was involved.

Operation was performed on the fifteenth day of obstruction. The condition was not recognized as the patient was in extremis. An artificial anus was performed, death following in thirty-six hours. Autopsy: The abdomen was widely opened. The intestinal loops were greatly distended but there was no trace of peritonitis. The sigmoid appeared at the right under the false ribs and was not greatly dilated.

It was then found that all of the intestine, including the large intestine, had undergone a movement of complete torsion around the root of the mesentery. This movement was from left to right. The intestines were in the right hypochondrium. The mesentery in the form of a sharp band passed obliquely over the large intestine at the level of the hepatic flexure; after having liberated the intestines a very deep stricture was found at the point compressed by the edge of the mesentery. The colon and cecum were greatly distended in front of this constriction. At the point of constriction the mesocolon presented traces of inflammation and it was retracted. There were a certain number of enlarged glands in the mesentery. The constriction was permeable for the little finger and the mucosa was normal. The musculosa was hypertrophied but there were no alterations except those of ordinary inflammation.

In 1902 Blecher reported an interesting case of a tailor, aged twenty-three.

His previous health and digestion were excellent. Sudden onset with shock and death in twelve hours on the operating table. Immediate autopsy findings: Large omentum was located in the left hypogastrium. Eventration showed the empty and pale duodenum, the empty and pale distal transverse colon, the dilated and deep red ascending colon and small intestine, all with a common mesentery and a very narrow mesenteric radix around which the intestines had made one complete torsion.

In 1903 Faltin briefly reported several cases from the University of Helsingfors, under the title of volvulus cecii. The following appear pertinent to this specific literature:

1. Farmer, aged twenty-one. Operation ten days after onset. Death same evening. The torsion was 180°. Operation comprised detorsion and cecopexy.

2. Maid, aged twenty-four. Several years' history of recurrent attacks of wandering abdominal pain with vomiting. Present attack of pain, vomiting and obstruction for three days. At laparotomy detorsion was made of the one and one-half times clockwise twisting of the small intestine, cecum and ascending colon. Death occurred on the fifth day. Autopsy revealed that the intestinal tract from the

jejunum to the transverse colon formed a continuous loop attached to a 15 cm. long, partially thrombotic and twisted common mesenteric radix.

3. Laborer, aged twenty-seven. Complained since childhood of periodic attacks of general abdominal pain and vomiting, relieved by enemata. For the past years these attacks recurred once or twice annually. Present attack began five days ago with nothing passing per rectum for three days. At laparotomy the very dilated lower ileum and cecum were found involved in one clockwise torsion. On puncture of cecum 2 liters of fecal fluid escaped. Death occurred on the third day postoperative. Autopsy findings revealed the entire small intestine, cecum and ascending colon attached to a common mesentery, to the right aspect of which the third portion of the duodenum was adherent. Also pneumonia right lower lung.

4. Woman, aged twenty-three. Admitted to the hospital at Wasa. Pregnant seven months. Complained of violent abdominal pain and vomiting after a fall. Opium medication was ineffective; constipation and vomiting persisted and were accompanied by pains resembling labor pains. The abdominal distention was most marked in the epigastric region and was not reduced by gastric lavage. A large enema produced some fecal matter. Patient was admitted to the obstetrical ward six days after her accident. Physical examination showed restlessness, accelerated pulse, normal temperature, persistent non-feculant vomit and marked abdominal distention. Premature labor was induced. As her condition was unchanged post partum, immediate laparotomy was done. Operative findings showed a portion of the small intestine, the cecum, ascending and transverse colon involved in a complete clockwise torsion, displacing the cecum near the spleen and underneath the costal arch. The dilated intestines were not gangrenous. A loop of the lower ileum was sutured to the wound for a proposed fecal fistula. Spontaneous postoperative defecation on the third day. Sudden death one week later apparently from perforating peritonitis. At autopsy the transverse colon was found perforated near the hepatic flexure.

In 1903 Wandel reported the following interesting case from the Pathological Institute of Basel.

Boy, aged seven, entered the clinic because of fracture of the left femur. Six days after admission patient began to vomit repeatedly and developed progressive to complete obstruction. There was also some rigidity of the neck and motor unrest. The tentative diagnosis was either basilar meningitis or acute gastroenteritis. Previous history revealed several attacks of partial intestinal obstruction and vomiting, all of which were relieved by hot abdominal packs. Death occurred on the eleventh day.

Autopsy findings showed normal conditions except in the abdomen. The duodenum and stomach were found markedly dilated. The common ileocolic mesentery was found attached to the posterior abdominal wall close below the pancreas. The transverse and ascending colon with the small intestine and the common ileocolic mesentery presented one complete torsion including the upper portion of the duodenum. The duodenojejunal flexure was missing. The anterior aspect of the great omentum was found adherent on the right to the transverse mesocolon, and through a tear in its posterior aspect some of the collapsed loops of the small intestine had slipped.

In 1904 Mohring reported the following case:

A woman, aged seventy-two, had recurrent attacks of severe abdominal pain, vomiting and constipation. The severity of pain and vomiting determined the necessity of operation. At operation much sanguineous fluid escaped and the small intestine and colon were torsioned so that the cecum and appendix were displaced near the spleen. After separating adhesions between the mesentery and small intestine and among the individual loops of the small intestine, the gut was detorsioned and the abdomen closed. Uneventful recovery with normal digestion and stools.

In 1904 Langerhans reported an interesting case:

A male patient, aged forty-three years, died of pulmonary tuberculosis. The common mesentery originated from the posterior wall of the abdomen, was 6 cm. broad and ran parallel to the upper transverse part of the duodenum. It spread out in a fan shape and on its right upper part carried the cecum, ascending colon and the right half of the transverse



## Brenner—Total Volvulus

colon, and the rest of its border, which was directed toward the left, carried the ileum and jejunum. The rectum, sigmoid and descending colon were normal; the left part of the transverse colon lay near the greater curvature of the stomach and was adherent to the omentum. In this region too, the transverse mesocolon was superficially adherent to the posterior lamella of the primary mesogastrium, but the transverse colon and its mesentery were nowhere adherent to the duodenum, so that on lifting up the freely movable ascending colon and turning it over to the left, the whole of the duodenum could be seen. As the mesentery with its root line ran horizontally above the duodenum and the transverse part of the duodenum, the mesentery was not crossed anywhere by the mesentery and the place where the duodenum passed into the jejunum was clearly visible.

The whole duodenum and the ascending colon were freely movable and the ascending free embryonic mesentery in which the head of the pancreas lay. The superior transverse part of the duodenum ran horizontally, the unusually long descending portion in an arch convex to the left and the inferior transverse part rose slightly and passed very gradually into the jejunum without any ascending part or duodenojejunal flexure. There was no part of it that was without a mesentery; and at the place where the duodenojejunal flexure is usually seen the mesentery was as long as that of the freely movable duodenum and jejunum. This was not so much an anomaly in the position of the intestine as an unusual direction of the root line of the mesentery and an absence of the physiological embryonic adhesions between the duodenum and the parietal peritoneum of the posterior wall of the abdomen, and between the large intestine and the duodenum.

Because of the absence of adhesions of the large intestine, the embryonic common mesentery, or the umbilical loop, as described by Toldt, was for the most part preserved. The other inhibitions of development, particularly the unnatural position and the shortness of the root line of the mesentery, were due essentially to the fact that the turn to the right of the common mesenteric plate was incomplete and corresponded about to the second stage as described by Broesike. This malformation was an inhibition of development that had affected different parts at different times and to different degrees.

In 1906 Danielson reported a case from Küttner's clinic at Marburg.

A married woman, aged fifty-five, had complained for years of painful gallstone colic, accompanied by severe vomiting. The attacks were short, but had increased in frequency and severity during the past year. Patient had once passed enteroliths but never any gallstones. On January 3, 1905, she had another attack with symptoms of intestinal occlusion. On admission to the clinic, the patient appeared cachectic. Rectal temperature was  $37.3^{\circ}\text{C}$ .; pulse 120. The persistent vomit had a slightly feculent odor. There was marked abdominal distention with a tumor mass in the left lower quadrant which was highly tympanitic. Enemata failed to relieve the condition.

At laparotomy the abdomen presented highly complicated conditions which could only be surveyed after eventration of the intestinal tract. The left iliac fossa was found occupied by the highly dilated, deep bluish-red cecum, whose elongated mesocecum was twisted beyond  $180^{\circ}$ . The cecum was completely surrounded by cyanotic markedly dilated mesentery of the small intestine, whose elongated torsioned pedicle of the mesocecum. The intestinal loops were adherent and the mesentery presented numerous residual fibrous scars of contracted mesenteric peritonitis. The collapsed transverse colon was found underneath the torsioned cecum and the appendix was displaced near the spleen. After detorsion the small intestine was correctly repositioned and the abdomen closed.

Postoperatively the patient improved and was able to keep down fluids. Defecation and flatus were regular. On the fifth day pulmonary symptoms suggested pneumonia. On the sixth day peritonitis set in, an artificial anus was performed, but the patient died.

In 1909 Blecher reported a case occurring in a carpenter, aged twenty-one.

The patient had had previous attacks of abdominal pain and vomiting. On admission he complained of increasing epigastric pain and vomiting. Physical examination showed pulse 70, slight and uniform abdominal distention, right abdomen painful on pressure, distended stomach and a continued cooing sound. The pain subsided under morphine medication. On the following morning patient vomited

fecal fluid containing a nematode. Simultaneous spontaneous defecation consisted of bright red blood. Toward noon similar bloody defecation occurred, associated with bilious vomit. Injections failed to induce bowel movements or the passage of gas. At operation the entire distended small intestine, the distended cecum and the ascending colon were found suspended on a common mesentery which was inserted to the right of the spinal column. The entire intestines had described a 180° torsion to the right, so that the descending duodenal portion passed laterally from the transverse colon into an intestinal loop descending obliquely to the left and joining the jejunum, then crossing the ascending colon from which it was separated by a markedly dilated artery simulating an intestinal loop. Near this point the volvulus had occurred. The mesentery was found hemorrhagic. A few lymph glands were swollen. The intestines were repositioned and the abdomen was closed in layers. Uneventful recovery. Reexamination after four months showed perfect digestion.

The author briefly reports 14 cases collected from the literature. He discusses predisposition to volvulus, symptomatology, diagnosis and surgical methods.

In 1910 Hübner discusses the etiology and clinical significance of the common ileocolic mesentery and the theories concerning the causes of intestinal volvulus set down in the specific literature. He states that up to date 15 cases have been reported—including his own, of volvulus of both small and large intestines, 11 occurring in males and 4 in females. In 10 cases the torsion was to the left, in 5 to the right. The author's case was reported from the Pathological Institute of the University of Rostock.

The patient was a boy, aged three. His parents reported that he vomited periodically at intervals of four to eight weeks. Latterly there was occasional abdominal pain. The boy had otherwise developed normally, had a good appetite and normal defecation. In January, 1909, a severe attack had been diagnosed as appendicitis and treated with opium and the application of ice bags. On May 29, 1909, during a recurring attack, the vomiting was persistent and the abdominal pain intense. On

palpation 2 cystic tumors were felt in the epigastrium and in the left lower abdomen respectively. They were thought to be hydatid cysts. On admittance to the clinic the boy was pale and restless. Temperature 37.4°C; regular, fairly strong pulse 110; respiration not accelerated. The right abdomen was soft; in the epigastrium and left hypochondriac areas a moderately tense cystic tumor was palpated. Vomiting, constipation and meteorism persisted. Examination under narcosis revealed a cystic tumor, size of a fist.

At laparotomy on June 1, 1909, a thin walled bluish cyst was delivered, about the size of a double fist, which was closely adherent to a compressed loop of the small intestine. The mesenteric cyst was punctured and voided a thin yellowish fluid that coagulated readily. Six centimeters of the collapsed intestinal loop were resected with the cyst. No free abdominal fluid was found or any adhesions. There were no symptoms of peritonitis and the intestine appeared normal in color and position. The abdomen was closed. Toward evening the boy repeatedly vomited, the pulse was small and swift, respiration was difficult, motor unrest and cyanosis set in and death occurred on June 2, 1909.

Autopsy findings showed about 80 c.c. sero-hemorrhagic abdominal fluid. The distended cyanotic cecum was located closely below the gall bladder, close below whose anterior pole the ileum joined the cecum from the left. The ascending colon started from the ileocecal valve obliquely to the left below and underneath the radix mesenterii, curved around it to the right, then turned to the left at the border between the pylorus and duodenum and formed a fairly normal left colonic flexure. The radix mesenterii was found as large as a small finger and completely compressed the colon underneath it. The radix also showed one 360° torsion and was encircled by a contracted and compressed loop of the jejunum which started from the duodenojejunal flexure at the left side above the point of insertion of the mesentery. After untwisting the radix the following anomalous conditions were found: a very large liver, the right lobe showing two small additional lobes; a very long ileocolic mesentery, mesocolon and large intestine; no hepatocolic or hepatorenal ligaments; no connection between duodenum and transverse colon; no duodenojejunal recess; hyperemic lymph nodes along the mesenteric veins; a v-shaped dis-

placed loop of the transverse colon simulating enteroptosis; torsion of the superior mesenteric artery and vein.

In 1913 Michaelis reported the following case:

The patient was a healthy, full term male infant, who nursed well and passed meconium. Two days after birth he passed black, decomposed, foul-smelling blood. No vomiting. Slight abdominal retraction. Symptoms progressive to death on the fourth day. The condition had been clinically diagnosed as melenae neonatorum, but was changed to volvulus of the small intestine and ascending colon after autopsy.

Post-mortem findings showed normal cervical, pulmonary, genitourinary and cardiac conditions. Moderate gastric distentions. General anemia. Abdominal conditions corresponded to those at the end of the fourth embryonal month, that is: appendix, duodenum, small intestine, ascending and descending colon had retained their own mesenteries respectively and the suspensory ligaments of the transverse colon were missing. The dark bluish-red loops of the small intestine were filled with blood and packed into the right abdomen. To the left of the median line along the left costal arch the distended dark bluish-red cecum was found superimposed upon these loops, together with the slightly twisted and full appendix. The empty ascending and descending colon were suspended by a narrow mesentery inserted in the center of the body in front of the spine. The colonic mesenteric radix presented a right rotation at  $540^{\circ}$ , the inferior horizontal portion of the flattened ascending colon being twisted one and one-half times around the torsioned radix. The superior mesenteric artery and vein were found completely twisted. The empty duodenum was found suspended by a fan-shaped duodenal mesentery inserted at the upper mesenteric end. Bauhin's valve showed peripheral thickening resembling a mushroom cap and blocked the intestinal lumen, leaving room only for the passage of a very small sound. Histologically the mucosa and submucosa near Bauhin's valve showed hypertrophy, while the colonic mesentery and walls of the small intestine showed hemorrhagic tissues.

The author states his inability to find in the available literature a similar case of

extensive volvulus in an infant. He also states that no successful operation for this condition has been reported so far. The author discusses the intrauterine development of the intestines, the etiology of volvulus, and the symptomatology with respect to infants presenting the disease. He briefly reviews 13 cases reported in the literature.

In 1919 Ombredanne reported a case of total voloulus with a chronic course.

It occurred in a girl of eleven years, who had had symptoms from the time she was weaned at eighteen months. Every few weeks there occurred attacks of pain and vomiting lasting two to three days. Between attacks she was apparently well. Operation consisted of a median, supra-umbilical laparotomy. The stomach was dilated; the pylorus apparently normal. The distended duodenum was followed downward and disappeared beneath coils of small gut. The transverse colon could not be seen. The incision was enlarged downward and the abdomen widely opened. The cecum and appendix were in the left iliac fossa under the abdominal wall. An examination was made of the region into which the duodenum disappeared and a vertical cord was felt corresponding to the mesenteric vessels. It was then realized that there was a total torsion of the intestine around this pedicle. The mass of intestine was rapidly eviscerated and it was found that the mesocolons had not coalesced with the posterior peritoneum at any point and that the large intestine was as free as the small gut. The entire mass of intestine was untwisted in such a manner as to place the cecum in the right iliac fossa after having brought it in front of the mass of small intestine. then a second half turn was made and it was again placed in the left iliac fossa by passing it behind the mass of small intestine. Finally a third half turn replaced it in the right iliac fossa by passing in front of the small intestine.

The torsion thus reduced amounted to one and one-half turns. However, there still remained a certain number of wide peritoneal adhesions in the axis of torsion. These were not very resistant but it was necessary to either section or tear them in order to permit (a) the transverse colon to extend freely upward to the lower border of the stomach; (b) the loop

of small intestine which surrounded the vascular pedicle to spread out toward the splenic region and to continue with the rest of the small intestine without angulation; (c) the distended portion of the duodenum to continue freely with a terminal part of the duodenum or the first part of the jejunum. In fact all of the dilated part of the duodenum was in a sort of cavity which opened upward and to the right which maintained this segment of the intestine against the posterior wall without there being any constricting band at any point.

When the duodenum was thus freed, it was the size of an orange. The parts were then in their normal positions and to fix them in this position four sutures were placed in the parietal peritoneum, two at the level of the flanks in the right and left hypochondriac regions and two lower down at the level of the anterior superior iliac spines. The two upper sutures included the middle segment of the colon which then was in the position of the transverse colon. The lower right suture was passed through the cecum and the lower left suture through the descending colon. The mass of small intestines was placed in the middle of this framework and the abdominal wall closed in the usual manner. Convalescence was uneventful and the patient was discharged on the seventeenth day.

In 1924 Braeunig reported the following case from the surgical wards of the Municipal Hospital at Worms.

Patient, aged twenty-one, was a strong healthy man, who was admitted two hours after the onset of violent symptoms of acute ileus. At immediate operation the entire small intestine and the beginning of the large intestine were found to have a common ileocolic mesentery and to be torsioned  $360^\circ$ . The transverse colon was placed retroperitoneally behind the small intestine. The gangrenous cecum and ascending colon were resected. Patient died twenty-four hours later.

The findings showed a small stomach situated vertically in front of the spinal column, the small curvature pointing upward and to the right, the large downward and to the left, the scant great omentum starting at this point. The intestinal portion corresponding to the duodenum was adherent to the spine by a short fatty mesentery and descended from the pylorus crossing in front of the transverse colon about 8 cm. below the pylorus. To the right of the

crossing the 25 cm. long free large intestine continued as the retroperitoneally situated transverse colon. At the crossing the small intestine was connected to the large with an indurated narrow strip of mesentery which broadened below and extended to the small pelvis. At its free right border were found the normal cecum and ascending colon; in its free left border were embedded the first loops of the small intestine. A Meckel's diverticulum presented 60 cm. distant from Bauhin's valve.

In 1926 Schottle reported 2 cases.

CASE I. Female, aged twenty-three, complained of irregular attacks of abdominal pain with constipation for three years. Symptoms were progressive. For six weeks prior to operation bowels were all but obstructed and patient daily vomited residual food. X-ray revealed partial obstruction at the junction of the horizontal and descending portions of the duodenum and the preoperative diagnosis was duodenal obstruction.

At operation, April 28, 1924, the great omentum was found unattached, the gastocolic ligament being absent. The small intestine, ascending colon and the proximal half of the transverse colon showed  $360^\circ$  clockwise torsion. Both intestines were freely movable to the middle of the transverse colon. Their common mesentery, 3 cm. in width, was inserted at the level of the second lumbar vertebra. The transverse mesocolon was partially lacking, beginning at the center of the transverse colon. The jejunum was found emerging on the right side about 10 to 12 cm. above the tip of the cecum. The anterior aspect of the duodenum showed extensive recent adhesions, while the ascending colon on the left abdominal side showed multiple old adhesions with the sigmoid. The torsioned intestines were repositioned and the abdomen closed. The patient was discharged cured June 3, 1924, with normal digestion. Six months later was in perfect health.

CASE II. Female aged 30, complained for two weeks of abdominal pain, belching, progressive distention and abstinence. Pain was intermittent in character and for two days was very severe. Temperature  $38.6^\circ$  C. Tentative diagnosis, appendicitis.

At operation, December 10, 1924, the peritoneal cavity contained clear yellow fluid. The cecum, ascending colon and all of the small intestine had made a torsion clockwise of  $180^\circ$

above their common mesentery. The cecum and ascending colon were greatly distended. The volvulus was reduced, the intestines repositioned and the cecum and ascending colon immobilized in their normal situ. Convalescence was uneventful except for the discharge of round worms. Patient was well two months later.

The author briefly reviews the literature and states that 20 cases have been reported to date, including his own. The 8 non-operated patients died. Of the 12 operated upon, 4 recovered. Fifteen of the 20 cases showed torsion to the right, such torsion varying from 90° to beyond 360°.

Three cases of common mesentery in which there were no symptoms of torsion have been roentgenologically diagnosed. Altschul published 2 cases of common mesentery thus diagnosed<sup>1</sup> and Schottle adds a third.

His patient was a man of thirty-five, sent to the roentgen section of the hospital for examination for obscure abdominal symptoms with a clinical diagnosis of amebic colitis. Past history was irrelevant except that when he was three years old he had been kicked by a horse in the abdomen but had soon recovered and suffered no special symptoms. The roentgen examination showed old hilus changes in the lungs which were of no significance. The stomach was normal. Examination two hours later showed masses of loops of jejunum and ileum lying on the right side of the abdomen and in addition to a small stomach residue the duodenum was filled. After six hours the ileum was empty; only the last loops of the ileum in front of Bauhin's valve could be seen and they were directed toward the left. They emptied into the cecum which did not lie in the right iliac fossa but in the left. The large intestine was exactly of the type described by Altschul. The ascending colon passed obliquely upward into the umbilical region and there formed a shallow flexure without crossing the midline, and then passed to the left and upward to the high and greatly distended splenic flexure. The descending colon ran normally down to the iliac fossa and then bent to form an atypical sigmoid. It passed up behind the descending colon to a hand's breadth below the splenic flexure,

<sup>1</sup> *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 32; nos. 5 and 6.

formed a band similar to that flexure and then passed in almost a straight line into the pelvis. At the time of the last mentioned examination it was completely full. This increased motility as well as the stippling and fraying of the outline of the haustra produced the typical picture of chronic colitis. But the important point is that the position and form of the colon were just like those described by Altschul. This made it probable that it was a case of common mesentery but the author still thought it possible that the accident in childhood might have had something to do with the displacement of the colon.

Some weeks later a second examination was made. This showed the stomach and duodenum in normal position but the lower flexure of the duodenum did not turn to the left but to the right. The appendix was also found to have a course opposite the normal. This proved that the malformation was a congenital one, such as Altschul described completely. The author agrees with Altschul that the flexure lying near the midline was not the hepatic flexure but the transverse colon. It showed the haustral segmentation so characteristic of the transverse colon. This means that the ascending colon must have been very much shortened as frequently happens. The author thinks beyond a doubt that this is a new case of common mesentery, though it was not confirmed by operation for which there was no indication.

Of the foregoing 30 cases found in the literature, 25 are positive cases proved by operation or autopsy. They have been reported in considerable detail because of rarity. Cases II and V are questionable ones and will be omitted from the discussion as will also the 3 cases based upon roentgenologic findings. To those 25 positive case reports the author adds the following 3 which occurred in two patients:

CASE I. R. Z., maiden, thirty years old, admitted to Post-Graduate Hospital October 7, 1924. *Past History*: Irrelevant except that patient has been very constipated since early childhood, but has always kept bowels regulated with physics and occasional enemata. One year ago had severe attack of abdominal colic with obstipation, distention and nausea. Treated for intestinal obstruction and was relieved in

twenty hours by catharsis and irrigations.

*Present History:* Thirty hours ago patient was suddenly seized with severe general abdominal pain, most marked in the left upper quadrant. Pains are colicky, intermittent in type, with paroxysms every ten minutes during which the patient is in agony. Is nauseated with each attack and has vomited small quantities of greenish watery fluid. Patient has had salts, castor oil and three enemata. No flatus or feces obtained.

*Physical Examination:* Temperature 101°F., pulse 66, respiration 24. White blood corpuscles, 9000. Polymorphonuclears, 78 per cent. Tall, thin, adult female. Looks acutely ill, tongue dry, tissues desiccated, abdomen tremendously distended. During examination had paroxysm of colic with visible peristalsis in upper abdomen passing from left to right. Flanks tympanitic, no evidence of fluid, no focal tenderness or rigidity. Rectal and vaginal examinations negative. It was thought that an indefinite sense of mass about the size of a grapefruit was felt in right midabdomen.

*Preoperative Diagnosis:* Intestinal obstruction from volvulus.

*Operation:* Under gas ether narcosis a mid-right rectus incision was made and a tremendously distended loop of transverse colon presented. The descending colon seemed collapsed. For that reason the incision was temporarily closed with towel clips and a 6 in. left rectus incision made which permitted the eventration of the hugely distended colon and loops of distended small gut. The pathology was most puzzling. It was noted that the descending colon and the recto sigmoid were collapsed. After some manipulation and much evisceration the colon was untwisted from left to right and was found to have made one complete twist (clockwise 360°) and in so doing had involved all the small intestine about a common mesocolic axis. The large and small intestine were acutely congested but at no point strangulated. There was considerable free hemorrhagic peritoneal fluid. Replacement of the distended bowel was accomplished only after passage of a rectal tube, the tip of which was milked up into the descending colon. A tremendous escape of gas permitted visceral replacement and the wounds were closed in layers without drainage.

Postoperative course was uneventful except for an annoying bronchitis with distressing cough. There was no postoperative vomiting or unusual distention. Bowels moved daily

without difficulty and patient was discharged on the twenty-fifth day. On November 11, 1924, patient reported that she felt very well. Digestion was normal. Bowels remained moderately costive but were easily regulated with petrolagar.

Patient remained well until July 3, 1925, when she was again suddenly seized with abdominal cramps, vomiting, progressive distention and complete obstruction which could not be relieved. Physical examination was the same as with the previous attack, but this attack seemed more severe and the patient was in shock. After ten hours of failure to relieve the obstruction, the left rectus incision was reopened and the identical pathology presented as at the previous operation. The patient was eviscerated and the volvulus of the cecum, ascending and proximal half of the transverse colon and all of the small gut had made one complete turn (clockwise 360°) about the duodeno-colic axis. The writer has never seen such great distention of the large bowel and feared its spontaneous rupture. The rectal tube was again employed, permitting reduction of the distention without an artificial vent. After detorsion a common mesentery to the small gut and the ascending and transverse colon was demonstrated. The transverse colon and its mesentery were nowhere adherent to the duodenum so that when the ascending colon was lifted upwards to the left the whole of the duodenum could be seen suspended from the common mesentery. The pancreas was fixed. The cecum and ascending colon were immobilized in the right lumbar gutter by peritoneal scarification and several interrupted chromic sutures.

Postoperative convalescence was uneventful and the patient left the hospital on the seventeenth day. She has been seen at intervals to date and has remained well, has no digestive disturbance except occasional flatulence, is only slightly constipated and has one or two daily movements with an occasional laxative. Her weight increased 25 lb. in eight months following the second operation.

*CASE II.* Mrs. J. B., aged twenty-six, sister of Dr. J. W., was treated by her brother for intestinal obstruction for thirty-six hours before coming to the hospital on August 1, 1925.

*Past History:* Irrelevant except for slight constipation. Patient suddenly developed acute abdominal cramps with vomiting, progressive abdominal distention and inability to pass

anything per rectum. She had received heroic treatment at home. Physical examination revealed a healthy young adult with markedly distended abdomen, having paroxysms of abdominal colic every few minutes. Temperature 100°F., pulse 84, respiration 22. Tongue dry; tissues desiccated; heart and lungs normal. Acute marked general abdominal distention with visible peristalsis in the upper abdomen, passing from right to left. No shifting dullness; no tenderness or rigidity. Rectal and vaginal examinations were negative. Preoperative diagnosis: Intestinal obstruction from volvulus. The writer facetiously remarked that it might be another rare case of total volvulus.

*Operation:* Through a 6 in. left rectus incision the hugely distended large bowel presented. Upon evisceration the pathology was akin to the previous case. The ascending and transverse colon had made a 180° twist from right to left, involving the small intestine about a common mesenteric axis. The cecum and appendix were in the region of the spleen. The large bowel was tremendously distended and again the passage of a rectal tube saved the necessity of a vent. After detorsion and replacement, the cecum and ascending colon were immobilized to the posterior parietal peritoneum to prevent recurrence.

Convalescence was uneventful and the patient left the hospital on the sixteenth day. Patient has remained well. Her digestion is good and bowels are regular with diet and an occasional laxative.

The predisposing cause of total volvulus is the persistence of the common ileocolic mesentery. Toldt, in 1879, demonstrated intestinal and mesenteric fixation to the peritoneum as secondary physiologic processes. Conditions may arise at any time during early embryonic life which can arrest or disturb normal development. The exciting factors producing the volvulus may be the direct or indirect effects of external force or physical strain, the mechanical effects of physiologic intestinal stasis and dilatation, or other undetermined causes.

With respect to symptomatology, one may distinguish two clinical groups: (1) strangulation, (2) obturation volvulus. The first group has very severe initial pain (the

acute pain of dying tissue), repeated vomiting, early distention and occasionally bloody stools, increasing collapse and sometimes rather sudden death. In the second group the attack progresses more gradually, the colic is less severe and intermittent, the distention more gradual and the vomiting less frequent. Collapse symptoms are absent.

The preoperative diagnosis is that of intestinal obstruction and immediate laparotomy is indicated. The operative findings may be difficult of interpretation due to great distention of the colon. An adequate incision which permits of eventration is imperative. A rectal tube passed during operation and milked up into the descending colon may greatly aid in reducing the colonic distention after detorsion has been accomplished. In the author's cases this saved the necessity of an artificial vent to permit replacement of the viscera. Following detorsion and repositioning the cecum and ascending colon should be immobilized to the posterior parietal peritoneum to prevent recurrence. The usual postoperative treatment for intestinal obstruction is followed, stressing the intake of fluids, chlorides and glucose.

Of the 28 positive cases proved by operation, autopsy, or both, 18 occurred in males, 10 in females. The ages varied from two days to seventy-two years, the average age being 22.5 years. In 9 patients there is no mention of any previous digestive disturbance; 17 had previous attacks of abdominal symptoms probably caused by partial torsion. Two cases were free of symptoms until the moment of volvulus. The torsion was clockwise in 23 cases and varied from 90° to four complete turns, the colon in no case revolving more than 540°. Of 7 patients who died without operation, 6 deaths were due to the volvulus, 1 to tuberculosis. Of the 21 laparotomies, 13 patients died, a mortality of 62 per cent. Those who recovered remained well except the author's case in which the volvulus recurred. The first successful operation for total volvulus was performed in 1904.



# TRAUMATIC LESIONS OF THE ABDOMINAL VISCERA\*

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NEW YORK

**I**NJURY to the intra-abdominal organs, or to other organs that produce symptoms referable to the abdominal cavity, constitutes a very important group of cases to diagnose and treat.

It is essential to divide the traumatic lesions of the abdomen into two groups: First: those resulting from penetrating objects, such as bullets and stab wounds. In any large city institution these cases are frequently seen, and it is generally agreed that all penetrating wounds of the peritoneum should have an immediate exploratory operation to determine a possible injury to a hollow viscus, and even in borderline cases when it is questionable whether the peritoneum has been penetrated by a foreign body, it is better to explore than to employ conservative treatment, because a general peritonitis may be prevented by repairing the wound early in the course of an injury, whereas an operation performed after peritonitis has developed usually results in a fatality. Second: In this group, where trauma has been produced by blows, kicks, falls or some heavy object hitting the abdomen, a diagnosis as to the exact organ injured is difficult. It is essential to consider first whether symptoms are due to the rupture of a solid viscus; secondly, to a rupture of a hollow viscus; thirdly, whether they are due to a retroperitoneal hemorrhage; and fourth, to a rupture of the lung or an injury to the diaphragm. During the past eleven years there have occurred on the Fourth Surgical Division at Bellevue Hospital 84 cases of injury falling under this heading.

*Diagnosis.* In diagnosing abdominal injuries the history and physical examination are of more importance than the laboratory and x-ray findings. If a careful history is

obtained in a suspected liver injury and it is found that the lower right chest, or right upper quadrant, was struck, and on physical examination there is evidence of trauma in this region, one will usually find that the liver was the organ damaged. The same holds true in cases of injury to the left chest and left upper quadrant, in which case the spleen is frequently the organ injured. Also, a fall or injury over the back at the lumbar region may result in a rupture of the right or left kidney, or a retroperitoneal hemorrhage. When the site of injury is directly above the pubis, the bladder is the organ most frequently involved, whereas injuries to the central portion of the abdomen usually means a rupture of the intestine, more frequently the small than the large, although the site of injury may at times be in the stomach, or on the other hand in the colon.

*Injuries to the Solid Viscera.* External evidence of trauma is a very valuable sign in making a diagnosis, but too much emphasis should not be placed upon its absence, particularly if there is a definite history of trauma to one of the aforementioned regions and local signs indicating such an injury. Of the 84 cases of injury to the abdominal viscera there were 64 injuries of the solid organs, as against 20 of the hollow viscera. The kidney is more frequently injured than any other solid organ. Next in importance is the spleen, and third the liver, but the relationship between the spleen and the liver is approximately the same, whereas the pancreas is rarely injured due to its protection by other organs.

*Injuries to the Hollow Viscera.* Of the total abdominal injuries, less than one-fourth involved injuries to the hollow

\* Read before the New York Society of Industrial Medicine, by Dr. Roland L. Maier due to the illness of the author, on May 14, 1931, Auburn, N. Y.



viscera, and, according to the location of lesion, the small intestine is more frequently injured than the bladder or large intestine.

*Retroperitoneal Hemorrhage.* Under this heading I am referring to cases in which there was a hemorrhage from a retroperitoneal vessel without injury to the kidney, liver, or spleen and in which the symptoms are referable to the abdominal cavity, due to pressure. There have occurred 3 cases in this group.

*Injuries to the Lungs and Diaphragm.* Chest injuries can frequently produce symptoms referable to the abdominal cavity and the patient may be explored for an abdominal injury with negative findings, and at autopsy the site of trauma found to be in the chest. Beekman<sup>1</sup> has stressed this point in a recent paper.

*Treatment.* In considering the treatment of these different lesions we are faced with a type of injury that requires careful thought and judgment. The tendency in the past has been to submit patients with abdominal injuries of a questionable diagnosis to exploratory laparotomies, and that probably is the teaching in most hospitals and clinics at the present time. Dr. Carl G. Burdick, Director of the Fourth Surgical Division, and the Children's Surgical Division, approximately seven years ago pointed out the inadvisability of submitting cases in which a questionable diagnosis existed to immediate laparotomy, as he found from experience on the Children's Surgical Service that borderline cases did much better under conservative treatment than by immediate laparotomy. Perhaps most of us questioned this at that time but I am sure we have seen the wisdom of his teaching during these years, and feel that unless one is reasonably positive that an injury to the hollow viscus actually exists, or one has evidence of a hemorrhage from a ruptured spleen, an immediate operation is not advisable. On the latter point I would like to take exception to a

recent statement of Fairchild's<sup>2</sup> in which he states:

We cannot make a diagnosis by conservative methods. If we explore we may find the condition is nonsurgical. If we do not explore we can deprive the patient of his chance to live. On what, then, should we base our decision for action? It would seem that it should be determined by the selection of that procedure which, if we are in error, will be attended by the least serious consequences. An error on the side of conservation, when surgery is required, may cost a life. The logic of the situation would seem to compel a decision for the radical procedure when serious doubt exists.

It is my opinion that the reverse of this statement holds true; that is, when in doubt one should never operate upon these cases of abdominal trauma. A detailed analysis of 53 cases<sup>3</sup> has recently been published and from the study of these one can see the reason for the conservative attitude. Beekman<sup>1</sup> in reporting 59 cases of abdominal injuries in children, states:

It is apparent, from the study of these cases, that it is not essential to submit all children with signs of abdominal injury to operation. In a small proportion of the cases (less than 7 per cent), operative intervention is necessary to save life; in a larger group it is not required and will in many cases precipitate death by the added shock or hemorrhage. It is evident that to carry out the proper treatment in an individual case the surgeon must know the condition he is dealing with. To determine this is difficult, as in many injuries of the abdominal and thoracic organs the only symptoms are those of peritoneal irritation. For this reason, I believe, it has become a habit for some surgeons to explore every patient with signs of intra-abdominal injury in the hope that he may find one of the conditions which can be benefited by operation. This would appear to be rather a small chance.

Added reasons for not operating are as follows: Of the 25 patients with kidney injuries, 23 were not operated upon, and there resulted a cure by conservative treatment. In cases of rupture of the liver which included 13 patients, 4

were operated upon with 2 deaths, and of the 2 that survived, the operation was not a factor in saving their lives but the patient lived in spite of it. In the other 2 cases it would seem that if they had not been operated upon they probably would have lived. In the 2 cases that died, each had a preoperative diagnosis of ruptured liver. One patient, thirteen years of age, was admitted in marked shock, with a blood pressure of 60. A transfusion of 250 c.c. of blood was given and the blood pressure raised to 90 over 60. The patient was operated upon and blood pressure fell to 64. There was no active bleeding at the time of operation and he was transfused with 400 c.c. of blood immediately following the operation and blood pressure was again raised to 90, but the patient died twelve hours later. The other patient was a man forty-five years of age, in moderate shock, with preoperative diagnosis of rupture of the liver. An exploratory laparotomy was performed but no active bleeding was found at the time of operation and the patient died ten hours later. It would seem from these cases that operative procedures in cases of rupture of the liver seldom do good and frequently do harm.

Injuries of the spleen will frequently recover by conservative treatment and if the patient is in marked shock he should have a transfusion and supportive measures before being submitted to operation; if his condition continues to improve an operation may not be necessary. If, on the other hand, there is evidence of continued bleeding, a splenectomy should be done immediately. In view of the fact that practically all patients with kidney ruptures, liver ruptures and some ruptures of the spleen will make an excellent convalescence and permanent recovery by conservative treatment, and these with retroperitoneal hemorrhages and chest

injuries constitute nearly 80 per cent of cases admitted for abdominal trauma, one can easily understand the wisdom of not being too radical in the handling of these patients in the early stages of injury. All of these patients should be given infusions immediately upon admission; the saline should be run in very slowly, a continuous infusion being used and approximately three hours for the first 1000 c.c. of fluid, four hours for the second 1000 c.c. and six hours for the third, being allowed. Of course, the patient's blood should be grouped and a transfusion given if it can be arranged, the transfusion being given slowly because the introduction of a large volume of blood into the circulatory system in a very short time may be a factor in dislodging a thrombus from the blood vessel and actually starting the patient to bleed again.

*Comment.* I would like to make it clear that in cases in which one is reasonably certain of an injury to a hollow viscus from traumatism to the abdomen, one should perform an immediate laparotomy. However, in cases in which the diagnosis is questionable, due to the symptoms being masked between those of a rupture of a solid organ, such as the liver, kidney, spleen, and retroperitoneal hemorrhage on the one hand, as against injury to a hollow viscus, it is to the patient's advantage to employ conservative methods of treatment rather than to submit him to immediate operation. If this principle is followed one will have a lower mortality and morbidity in cases of injury to the abdominal viscera.

#### REFERENCES

1. BEERMAN, F. Treatment of abdominal injuries in children. *Ann. Surg.*, 90: 206, 1929.
2. FAIRCHILD, F. R. Serious intra-abdominal trauma without external evidence of violence. *Surg., Gynec., Obst.*, 52: 767, 1931.
3. HINTON, J. W. Injuries to the abdominal viscera. *Ann. Surg.*, 90: 351, 1929.



# STRANGULATED FEMORAL HERNIA

GANGRENE OF ILEUM; ANASTOMOSIS WITH DELAYED RESECTION\*

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**B**ECAUSE it brings out some interesting and unusual features I report the following case:

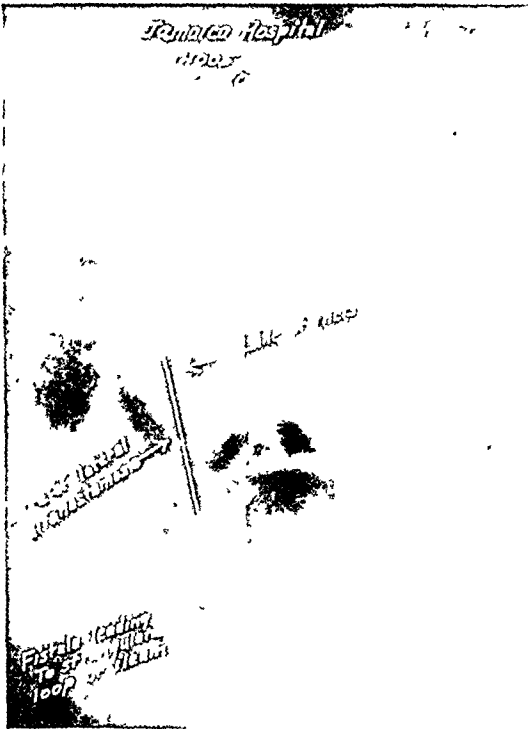


FIG. 1.

A female, aged sixty-five years, a widow, was admitted to the Jamaica Hospital December 21, 1929.

She had a femoral hernia for about five years.

On December 19, 1929 she was suddenly attacked with sharp, colicky pains in the region of the right groin. The pain became progressively worse. A few hours later nausea and vomiting occurred. Enemas gave some relief but only gas was expelled.

The history elicited that the condition had become worse. Vomiting persisted throughout the following day. The mass in the femoral region was larger but less painful.

The writer saw her on December 21. He ordered that she be sent to the hospital.

On examination the patient appeared to be acutely ill. The face was anxious and pinched, the eyes sunken, skin cold, and the mucous membranes cyanotic. The pulse was 90 but weak and easily compressible. The temperature was 97.6°F. by rectum.

The abdomen was distended and tympanitic. A mass in the right groin and extending over Poupart's ligament, the size of a grapefruit, was present and tender and dull on percussion.

The patient showed a leucocytosis of 13,900 with apolymorphonuclear count of 79 per cent. In the urine were albumin, some pus cells, and hyaline casts. The non-protein nitrogen was 40 mil per 100 c.c. blood.

Operation was decided upon.

Prior to going to the operating-room she was given 2000 c.c. of normal saline under the skin, her stomach was lavaged and morphine sulphate grs.  $\frac{1}{6}$  and atrophine  $\frac{1}{150}$  was administered.

Anesthesia was a mixture of gas, oxygen, ether and ethlene.

The operation consisted of an incision directly over the mass. The sac was entered. The sac discharged serum, part clear and part bloody. In the sac was a loop of the lower portion of the ileum about 12 inches in length. This was distended, edematous and covered with a fibrinous exudate. It was purplish in color, had areas of ecchymosis and was lusterless. There was a distinct *B. coli* odor. The mesentery showed essentially the same changes with areas of thrombosis. The ileum was opened between two clamps and a large amount of bloody fluid recovered. A rubber tube was inserted and transfixed in the ileum, according to Witzel's technique. The wound was dressed with vaseline and dry sterile gauze.

Postoperatively she was placed in a Fowler position and treated as for shock. Fluids were pushed. The highest temperature was 100°F. and the pulse never went above 100. Vomiting stopped and the distention subsided.

On the third day postoperative it was decided to resect the ileum. A low, right

\* Submitted for publication August 4, 1931.

rectus incision above the site of the hernia was made. An active, localized peritonitis was found. It was decided not to proceed further. The wound was closed and the patient was returned to bed.

For six days following this attempt the patient was uncomfortable. Distention with intermittent vomiting occurred. The temperature rose to 102.6°F. and the pulse to 120. Her stomach was lavaged and she was given fluids by clysis. The wound was not disturbed. On December 29, six days following the second operation, the temperature reached normal and remained so. The tube was expressed on the seventh day. Active feeding was begun.

The patient continued to improve and her general condition and laboratory findings were such that on January 9 (nineteen days following her admission to the hospital) another attempt at resection seemed in order.

Therefore, a right rectus incision above the site of the hernia through the peritoneum was made. An attempt to reduce the hernia from above was unsuccessful because of the presence of dense adhesions. Suddenly the patient reacted poorly to the anesthesia. Two loops of ileum proximal to the neck of the sac were selected and a lateral anastomosis was quickly performed. The wound was closed in layers. The following five days were stormy. The temperature rose to 104°F. and the pulse became rapid, intermittent and small. The general appearance of the patient showed a critical condition. Frequent small doses of whiskey were given and fluids were given by clysis. On the fifth day phlebotomy was performed and 500 c.c. of whole blood by the Pfarre method were given. Following this the patient improved. The temperature slowly returned to normal. Gas

was expelled per rectum and feces were present seven days following the anastomosis. Convalescence continued and she was discharged on February 19, sixty-one days after admission.

An x-ray taken on February 7 showed the ileostomy functioning, ileal anastomosis functioning, ileal adhesions to the right of the incision, and colonic hypomobility probably contingent upon the actively functioning ileostomy. On February 13 an opaque enema readily filled successive portions of the colon, meeting with no obstruction.

The patient reentered the hospital on May 13 for a delayed resection.

Spinocaine anesthesia was used.

The operation comprised:

1. Ileostomy closed by purse-string suture.
2. Incision over the right rectus, excising all previous scars.
3. Peritoneum opened and small intestine dissected away from the adhesions to the parietal peritoneum.
4. Previous anastomosis identified and small intestine resected distal to it.
5. Proximal ends of resected gut inverted by purse string suture.
6. Resected portion of gut freed from adhesions by sharp and blunt dissection and removed from sac.
7. Wound closed in layers and sterile dressings applied.

The patient made an uneventful recovery and was discharged from the hospital May 29, 1930, seventeen days after admission.

The patient was seen December 22, 1930. She reported her bowels were active and normal. She was doing her housework. The wound was firmly healed. Her general physical condition was excellent.



# RECURRING OMENTAL HYPERTROPHY

## SIMULATING ABDOMINAL TUMOR\*

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THE omentum is the good samaritan of the abdominal cavity, always ready to render aid and but seldom becomes sick itself. Occasionally however, it becomes the innocent bystander and suffers for the sins of its neighbors. (Hertzler).

Hypertrophy of the omentum, sometimes called epiploitis or omentitis, is an unusual condition and infrequent enough to mention. The case to be reported here is of interest first because of it being a primary hypertrophy and second because it so closely simulated an abdominal tumor.

### CASE REPORT \*

Female, age 47, white.

*Chief Complaint:* Enlargement of abdomen.

*Present Complaint:* About one year ago, the patient's attention was drawn to a sense of fullness and heaviness in the left lower quadrant. The discomfort turned to pain which became increasingly worse until it was so disturbing as to force her to seek the advice of a physician. She was informed that she had an ovarian tumor and that an operation was indicated. The patient waited for further developments and noticed that when she leaned forward or turned around in bed, it felt as though something heavy moved around in her abdomen. She also noticed a gradual enlargement of the left side of her abdomen associated with nausea and vomiting which she attributed to the dragging sensation. Due to the epigastric distress associated with the ingestion of food, the patient refused to eat, thus causing a noticeable loss of weight which compelled her to seek further assistance.

*Past History:* Negative.

*Menstrual History:* Past menopause; three children living and well. No miscarriages or previous operations. The patient went to two other physicians, who made a diagnosis of ovarian tumor.

*Examination:* General: Rather well built individual who does not look acutely ill. Skin

rather loose, indicating probable loss of weight. Temperature normal, pulse 70, blood pressure 110/70. Head, neck and chest reveal nothing.

*Abdomen:* Not distended, rather a normal contour except that there was a definite elevation in the left lower quadrant as compared to the other areas of the abdomen. Palpation revealed a well-relaxed wall, with a definite mass which seemed to be tender and confined to the left of the umbilicus. The mass seemed movable and rather firm to touch. Percussion gave a solid note.

*Vaginal:* Pelvic adnexa distinctly felt, with a mass to the left and above. The mass did not seem attached to the pelvic organs in any way and the hand could be placed definitely between the mass and the pelvis.

*Laboratory findings:* Urine and blood did not reveal anything abnormal. Stool negative.

*X-ray findings:* negative for gastrointestinal and genitourinary tract.

*Impression:* 1. Abdominal tumor; pediculated ovarian tumor. 2. Malignancy.

*Operation:* Under gas and ether anesthesia, the abdomen was entered through a median incision. A large mass presented itself. This mass was delivered and found to be the lower third of the omentum. It was greatly thickened, lobulated, hemorrhagic and dark. It was so firm in its consistency that it made us think of a possible malignancy. There was no twisting or volvulus. So much of the omentum seemed involved that its removal impressed us as poor surgical procedure. The pelvic organs and spleen were normal; there was nothing abnormal about the gastrointestinal tract. The appendix was easily accessible and was removed in the usual manner. A section of the omentum was removed for further study and the abdomen was closed in the usual fashion without drainage. The patient made an uneventful recovery and left the hospital in two weeks.

*Pathological Report* (by Dr. S. H. Grey, Pathologist): Section is a small piece of tissue consisting of fat, connective tissue and red blood cells. The latter occur as several small

\* From the Departments of Surgery, Washington University Medical School and The Jewish Hospital, St. Louis.  
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hemorrhages. The connective tissue is neither proliferative nor excessive; it is found as a slight diffuse increase and in some places as small accumulations. Practically no lymphocytes are found.

*Postoperative Course and Follow-up Notes:* The mass seemed to recede in size immediately following the laparotomy. The patient went on to a complete recovery and remained well for five years when she again commenced to experience a repetition of the symptoms she had experienced prior to her operation. These were not as severe. This attack lasted about six months and then disappeared without interference. It is now ten years since her operation and excluding the six months of trouble five years ago, the patient has been in good health.

Recent literature on this subject is scarce and especially lacking in reference to the pathology of this condition. Two types of omental hypertrophy or omental inflammation have been described: one secondary to procedures in the abdomen and the other in which the omental pathology is primary. The latter variety is extremely rare.

Cases which follow an intra-abdominal operation are most frequently found where ligation of the omentum has been performed. This is frequently the case in hernia operations where the omentum is previously adherent to the sac and has to be ligated in its removal. This condition has been called "acute inflammatory tumor of the omentum," and Braum states that in this condition, an inflammatory process, usually makes itself evident from one to ten weeks following any operation in which the omentum has been tied off. Emerson<sup>2</sup> from a study of 3 cases, reports inflammatory condition of the omentum following operative procedures. He calls this condition "omentitis hypertrophicae" because of the marked hypertrophy of the omental tissue involved. Attention should be called to the fact that, microscopically, he reports very little, if any, deviation from the appearance of a normal fatty infiltrated omentum.

Primary hypertrophy of the omentum is exceedingly rare. Both D. S. Adams<sup>3</sup> and C. A. Hamann<sup>4</sup> report cases of omental inflammation in which there is no history

or knowledge of a previous abdominal operation. The symptoms in these cases resembled abdominal tumor and appendicitis, and were diagnosed only after the abdomen was opened.

In the case reported in this paper, a striking fact was the finding of this angry red-orange hypertrophied omentum which to all macroscopic examination appeared to be an acute inflammation of the part involved or a possible malignancy. Much to our surprise, we found that the microscopic report did not reveal any of the findings which are usually associated with an inflammatory condition. In this entire mass, which appeared to be acutely inflamed, we found no adhesions or signs of exudate which usually accompany an acute inflammatory process.

Emerson, it will be noticed, calls this condition "omentitis hypertrophicae" because of the marked hypertrophy found. He states very little about any inflammatory findings.

#### CONCLUSION

We feel that the true nature of this primary hypertrophy is probably not associated with any inflammatory condition especially in view of the lack of microscopic findings to substantiate the term "omentitis or epiploitis," thereby suggesting a state of inflammation. We wonder if this hypertrophy might not be due to some circulatory interference rather than an infection in which the omentum becomes enlarged, edematous and hemorrhagic.

The term "omental hypertrophy" seems much more appropriate to us in view of our findings than omentitis or epiploitis, which suggest the association of the pathology with an inflammatory condition.

#### REFERENCES

1. HERTZLER, A. E. In: *Graham's Surgical Diagnosis*. Phila., Saunders, 1930, Vol. 2, p. 624.
2. EMERSON, C. "Omentitis Hypertrophica," new clinical entity. *Nebraska M. J.*, 14: 29-31, 1939.
3. ADAMS, D. S. Primary acute inflammation of the great omentum; case report. *Boston M. & S. J.*, 189, 981, 1923.
4. HAMANN, C. A. Surgical conditions of the great omentum. *Ohio M. J.*, 11: 685-687, 1915.

# CHRONIC ULCERATIVE COLITIS

## SURGICAL TREATMENT WITH A REPORT OF THREE CASES, SEVEN, EIGHT AND NINE YEARS LATER\*

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IT is not the purpose of the authors to debate the question of the modus operandi of treatment of this condition, in the light of present-day knowledge of this condition. Rather is it the purpose to report 3 cases which were treated by the use of a surgical procedure, and the results obtained after a period of seven, eight and nine years respectively, which we believe is a long enough period, without recurrence of symptoms, to satisfy ourselves that a cure has been effected.

Since the work of Barger<sup>1</sup> in 1924, the surgical treatment of this condition has been held in abeyance, due to the excellent results obtained by the use of his serum or vaccine. In 1924 Barger isolated a diplostreptococcus from the ulcerations in the colon in cases such as these, and demonstrated their presence in the blood stream in the acute stages of the disease, and in various organs at necropsy. He has also demonstrated that the implantation and the injection of this organism into the lower animals caused the occurrence of this condition. The isolation of this organism stimulated research along these lines and since that time the use of surgery in this condition has been kept rather in the background.

Weber<sup>2</sup> working with Barger in 1930, gives us a comprehensive method in the roentgenological diagnosis of this condition. The absence of haustrations and the presence of a sausage-shaped tumor or shadow involving the descending and sigmoid colon are the usual findings, as well as a loss of motility or rather tube-like contractions of the colon.

Barger and Comfort<sup>3</sup> state in a review of 893 cases that polyposis was found to

exist in 10 per cent of the cases. This is interesting, in that 1 of the 3 cases reported here, had a polyposis of the colon which, on proctoscopic examination one month after operation was shown to be undergoing atrophy.

All 3 cases that we are reporting were treated surgically following a long course of unsatisfactory medical treatment. The technique used, followed that advocated by John Young Brown.<sup>4</sup> It differed in that, instead of our performing an appendectomy and cecostomy at the first stage, only an ileostomy was performed; and at the second stage when the ileum was reanastomosed to the cecum, an appendectomy was applied as a prophylactic measure against gas tension at the suture-line of the ileocecostomy. At the first stage the ileum was severed close to its junction with the cecum and brought out onto the abdominal wall and fixed to act as an artificial anus, thus putting the colon at complete physiologic rest. At the second stage when the ileum was reanastomosed to the cecum, an appendectomy was applied. After a few days the distal third of the appendix was severed and was accompanied in all cases with an escape of gas and thus the tension was removed from the anastomotic suture-line. In a few days the appendix became black and was permitted to slough off. No ill-effects followed this procedure.

Brown, in his original article, cites 10 cases treated in this manner. He stated that 3 were done for the relief of amebic dysentery. However, most authors question the efficacy of this operation for the relief of amebic dysentery. The operation enjoyed considerable popularity for a time and was advocated by many, including

\* Submitted for publication April 24, 1931.

Logan who, in 1918, advocated its use for the relief of this condition.

All are agreed that the value of rest in the treatment of inflamed abdominal organs has long been recognized. The Crile treatment of peritonitis and the starvation treatment of Ochsner, have for their purpose the arrest of intestinal peristalsis. Complete physiological rest of certain portions of the large bowel, as accomplished by a colostomy, is of well known worth.

The reports of these 3 cases are merely an indication of the value of complete physiological rest. Also, these 3 cases antedate the work of Barger and others, and up to the present time the patients have had no recurrence of symptoms and therefore are all reported as cures.

The three most valuable points in arriving at a diagnosis are examination of the stool, proctoscopic examination and the roentgenographic appearance after barium enema. Unfortunately, in the 3 cases reported, there were roentgenograms taken in only 1 case before operation.

#### REPORT OF CASES

**CASE 1.** G. L. F. entered the Soldier's Home hospital Dec. 5, 1921. At that time he stated that he had lost about 29 lb. in the past six months. He had absolutely no control over his bowel movements. Sometimes they would reach 15 a day. He stated that he had been troubled with the condition for the past ten years, but that it had become increasingly worse the past six months. Except for an attack of influenza in 1918 he had enjoyed excellent health. He also gave a history of a questionable chancre in 1909.

*Physical Examination:* The patient was a greatly emaciated and dehydrated male adult, forty-six years of age, who weighed 129 lb., his normal weight being 158 lb. Except for the following, the physical examination was negative. The tongue was dry and fissured. The lips were cracked and extremely dry. The teeth showed a high degree of caries. The abdomen was somewhat distended and gurgling sounds were heard. There was tenderness along the course of the descending and sigmoid colon. The rectum was prolapsed and the sphincter control was entirely lost.

*Laboratory Findings:* The urinalysis was negative. The red blood corpuscle count

was 4,300,000. The white blood corpuscle count was 8600. The differential count was polymorphonuclears 73 per cent, lymphocytes 23 per cent, mononuclears 3 per cent and basophiles 1 per cent. Stool examination on three occasions was negative for endameba histolytica. The Wassermann test was negative at the time. However, subsequent reactions showed a 2 plus on two occasions.

The patient was treated as a case of amebic dysentery at the time. He received ipecac by mouth and emetine hydrochloride by hypodermic injection as well as enemas of cinchona 1/4000 solution. The patient continued to lose weight, losing 8 lb. in ten days. The patient remained in bed and had numerous bowel movements containing a great amount of blood and pus.

Feb. 6, 1922 he was transferred to the surgical service. Roentgenograms of the colon showed a stricture to exist at the lower portion of the sigmoid colon. The entire colon had the appearance of a tube, as there were no contraction waves present. Proctoscopic examination performed on Feb. 18, 1922, revealed many polypi and many undermined ulcerations. Scrapings taken from the edges of the ulcers failed to produce endameba histolytica.

*Operative Findings:* Operation performed on Feb. 21, 1922, by Dr. Mensing disclosed a pale, enlarged, edematous colon, filled with a doughy mass, which was undoubtedly due to the polyposis. At this time an ileostomy was performed according to Brown. The ileum was severed close to its junction with the cecum and the cecum closed. The opening in the ileum was brought out onto the abdominal wall and fixed, and a Paul's tube placed in the opening and attached by means of a rubber tube to a bottle. The patient encountered no difficulties following operation. He had three acts of defecation through his anus and then had no more until after the second stage of the operation.

Proctoscopic examination performed on March 25, thirty-two days following operation, showed pock marking throughout the sigmoid colon, these marks being the sites of the healed ulcers. At that time there was very little polyposis and what few there were, were undergoing atrophy. Proctoscopic examination performed on April 30, showed a complete healing of the ulcerated areas and an absence of polypi.

On May 23, three months following the first stage, the second stage of the operation



was performed. The ileum was reanastomosed to the cecum, immediately above the ileocecal valve, and the appendix was brought out through the incision and fixed to the abdominal wall. On the third day following operation, the distal third of the appendix was severed and gas escaped, thus relieving tension on the suture-line. The appendix became progressively black and sloughed off. Some ten days later the patient had an attack of diarrhea, from which he quickly recovered and was discharged from the hospital June 22, 1922, as cured. The patient was seen on March 6, 1931 and stated that he had been in the best of health since his discharge from the hospital, and that at no time did he have any recurrence of the condition. He has been working steadily since his discharge.

Proctoscopic examination performed on March 10, 1931, revealed a mucous membrane paler than normal, with many pock-mark scars. There are no signs of polyps in the rectum.

Roentgenographic studies of the colon following a barium enema on March 8, 1931, reveal slow filling of the colon at the lower portion of the sigmoid; after passing this point of partial obstruction, the remainder of the colon fills normally. No tenderness is noted at the point of obstruction to the inflow of the opaque media and the examiner feels that this is a point of stricture rather than an obstruction due to an infiltrative process.

CASE II. E. R. W. entered the Soldier's Home hospital Oct. 25, 1923. At entrance the patient stated that he had been suffering with severe abdominal cramps for the past six months. He stated that he had been having ten to fifteen bowel movements a day. These stools have been made up, for the most part, of blood and pus, and he stated that they had an extremely offensive odor. He had lost 21 lb. in the past six months. The family history was irrelevant. He had a varicocelelectomy performed in 1920. He had an attack of influenza and pneumonia in 1918. Otherwise the past history was negative.

*Physical Examination:* The patient was an adult male, white, aged twenty-one years, who weighed 119 lb. His normal weight was 140 lb. The patient was somewhat dehydrated and extremely undernourished. The tongue was dry and fissured. The lips were dry and cracked. The abdomen was moderately distended with moderate tenderness over the descending colon. The anal sphincter was lax and there was a first degree prolapse of the

rectum. Otherwise the physical examination was negative.

*Laboratory Findings:* The urinalysis was negative. The R.B.C. count was 5,300,000. The W.B.C. count was 11,800. The differential count was polymorphonuclears 74 per cent, lymphocytes 24 per cent, mononuclears 2 per cent. Subsequent blood counts revealed little if any change. At no time was there an eosinophilia present. The Wassermann reaction was negative on two occasions. Examination of the stool on seven occasions failed to produce *endameba histolytica*. Material taken from the edges of the ulcers at time of proctoscopic examination failed to produce any ameba.

The patient was placed on the medical service and was treated without any appreciable change in his condition.

Proctoscopic examination performed on Oct. 29, 1923 showed ulcers to be present as high as the rectosigmoid junction. There were many miliary ulcers present.

Operation performed on Nov. 5, 1923, by Dr. Mensing. At this time an ileostomy was performed. The patient exhibited no unusual after-effects.

Proctoscopic examination performed on Dec. 13, 1923, thirty-eight days following operation, showed a few pinpoint ulcers to be present which bled easily. At this time the patient was placed on daily colon irrigations of silver nitrate, 1/10,000 solution.

Proctoscopic examination performed Jan. 20, 1924 two and one-half months following operation revealed pock-marking and the complete absence of ulcers.

On January 22, 1924, the second stage of the operation was performed. The procedure was the same as followed in the first case. The ileum was reanastomosed to the cecum above the ileocecal valve, and an appendectomy was done. Three days following operation the distal third of the appendix was severed.

The convalescence was uneventful and the patient was discharged Feb. 16, 1924.

The patient has not been seen since that time, but in corresponding with him, it was found that he has had no recurrence of the condition up to the present time. Inasmuch as eight years have passed since his hospitalization, we have concluded a cure as existing in this case.

CASE III. A. B., male white, aged fifty-five years, entered the Soldier's Home hospital on June 2, 1924. Complained of severe abdominal cramps, with an extremely great number of

stools a day, sometimes reaching forty in number. He stated that for the past four years he had been suffering with this condition. However, at the time of entrance he stated that the condition had become considerably worse the past four months. The patient had lost some 15 lb. in the past four months. The family history was irrelevant. The patient had an attack of typhoid fever in 1906. He had an attack of malaria in 1896. He also stated that he had an attack of dysentery while residing in New York State in 1900, from which he made a rapid recovery. Otherwise the past history was negative.

*Physical Examination:* Male, white, aged fifty-five years, who weighed 130 lb., his normal weight being 150 lb. The tongue was dry and the lips dry and cracked. The patient was extremely undernourished and dehydrated. The abdomen was moderately distended, with tenderness in the left iliac region. The liver and spleen were not palpable. The rectum showed considerable prolapse and the sphincter was very lax. Otherwise examination was negative.

*Laboratory Findings:* The urinalysis was negative. The R.B.C. count was 5,100,000. The W.B.C. count was 8600. The differential count was polymorphonuclears 75 per cent, lymphocytes 20 per cent, mononuclears 3 per cent, and basophiles 2 per cent. Subsequent blood counts failed to reveal an eosinophilia. Examination of the stools on six occasions failed to reveal any endameba histolytica.

The patient was placed on the medical service and received anti-dysenteric treatment. A low proctoscopic examination performed on June 6, 1924, showed many ulcers to be present. However, before anything further could be done, the patient left the hospital to enter the Mayo Clinic, on June 16, 1924.

The patient was re-admitted to the hospital on August 24, 1924, with the same complaint, with the exception that he had lost considerably more weight and seemed a great deal more dehydrated. At the Mayo Clinic the condition was diagnosed as chronic ulcerative colitis.

Proctoscopic examination performed on Aug. 29 showed many large undermined ulcers involving the colon and the sigmoid. There were many miliary ulcers present. Material taken from the edges of the ulcers failed to produce endameba histolytica.

Operation performed on Sept. 4, 1924, by Dr. Mensing. At this time an ileostomy was

performed as in the first 2 cases. The patient had two bowel movements of blood and pus through his anus six and ten days respectively, following operation, and then had no more until after the second stage of the operation.

Proctoscopic examination performed Oct. 2, 1924, one month following operation showed an absolute absence of any ulcerations in the colon. There were many pock-mark like depressions, the site of the former ulcers.

The second stage of the operation was performed on Oct. 7, 1924. At this time the ileum was reanastomosed to the ascending colon above the ileocecal valve and an appendectomy was applied. Two days later the distal third of the appendix was severed. The appendix became black and sloughed off eleven days following operation. The patient made an uneventful recovery and was discharged as cured November 8, 1924.

The patient was seen on February 17, 1931 and stated that at no time had he had any recurrence of the condition since he left the hospital in 1924. His bowel movements are normal and he is in the best of health. Proctoscopic examination performed on March 13, 1931 showed the mucous membrane to be paler than normal. In the upper third of the rectum and the beginning of the sigmoid there are numerous white scars linear in shape and about 1 mm. in length.

Roentgenographic findings by means of a barium enema on March 10, 1931, reveal no obstruction to the inflow of the opaque media. The lower portion of the descending colon does not fill in its entirety and manipulation reveals no tenderness. The transverse colon fills normally. It is the opinion of the examiner that the incomplete filling of the descending colon is due to a loss of tonicity rather than to any pathology.

*Comment:* Three cases are set forth as an example of the efficacy of complete physiological rest as applied to the large bowel. These cases all had considerable medical treatment, and the application of an ileostomy affording complete rest to the large bowel has restored the men to health. The 3 patients presented were the only ones operated on in this hospital, and as the results obtained are excellent, we have no surgical failures to report.

[For References see p. 61.]

# ACUTE INTESTINAL OBSTRUCTION BY LARGE GALLSTONE\*

ALEXANDER VAN RAVENSWAAY, M.D.

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**F**EBRUARY 7, 1931, a lady seventy-one years of age entered St. Joseph's Hospital, Boonville, Missouri, accompanied by her

morphonuclears 40 per cent, lymphocytes 15 per cent, stabkernige 45 per cent. Urine contained a trace of albumin and occasional pus and blood cells.

The diagnosis made was: intestinal obstruction, cause unknown. An exploratory laparotomy was performed. After lavage of the stomach and intravenous administration of 400 c.c. 10 per cent glucose solution, patient was brought to operating room. Operation was performed under spinal anesthesia, using 100 mg. novocaine in 4 c.c. spinal fluid. A subumbilical median incision large enough to allow entrance of the examining hand was made. A hard mass was felt in the small intestine. The loop containing the mass was delivered through the opening of the abdominal wall, the bowel was carefully opened and mass was removed. After suturing the opening in the intestine it was put back into the abdominal cavity. No other masses were felt in the intestines.

Patient stood the operation well and made a good recovery until the tenth postoperative day, when she felt slight pain in the abdomen and began vomiting again. Rectal examination revealed another stone high up in the rectum. This stone was removed manually. From then on her recovery was uneventful.

The mass removed was examined in the Laboratory of Pathology of the University of Missouri and was reported to be a gallstone. Its size can be judged by comparison with a golf ball, as illustrated in the accompanying photograph.

This case is instructive because it shows that large gallstones can gain entrance to the bowel, probably, in this case, by perforation into the stomach or duodenum, and then cause intestinal obstruction.

\* Submitted for publication May 5, 1931.



FIG. 1.

family physician who had made a diagnosis of acute intestinal obstruction.

History given by patient showed that she had been constipated for the last twenty years and that she had taken laxatives regularly. Two days before admittance to hospital her abdomen began to get sore and her bowels refused to move, notwithstanding laxatives and enemas. Her abdomen became distended and she was unable to retain fluids, vomiting all fecal fluid.

Physical findings at the time of patient's admittance to hospital were as follows: slightly obese female, apparently in pain, tongue fairly moist, not much dehydration, pupils regular and reactive, chest negative, heart negative, blood pressure 125/90, muscular rigidity of abdominal wall, abdomen slightly distended but no masses felt, rectal examination negative, vaginal examination negative and reflexes normal. Laboratory findings were: white blood count 15,600, hemoglobin 90 per cent (Tallquist), differential count: poly-

# FISTULOUS TRACTS

## THE DIAGNOSTIC VALUE OF AN OPAQUE MEDIUM OF KNOWN CONTOUR AND CONSISTENCY\*

W. WALTER WASSON, M.D.

DENVER, COLO.

FOR several years, I have been using the x-ray ureteral catheter, an opaque medium of known shape and con-

sistency, with the exception of Tuffier<sup>3</sup> who inserted a piece of metal wire through a rubber catheter to insure rigidity and



FIG. 1. Demonstrating use of x-ray ureteral catheter in diverticulitis of bladder.

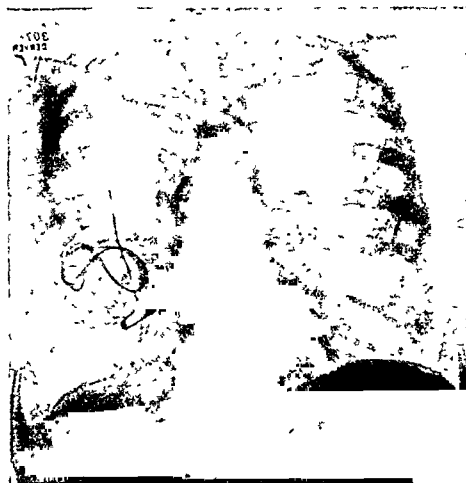


FIG. 2. Catheter coiled in cavity of lung abscess. (Safety pin indicates external end of drainage tube.) Type 1.

sistency, in the diagnosis of fistulous tracts. Because of the importance and value of an examination which embodies its use, I am reporting it now, and not with any thought of originality.

Catheters and bougies are far from new. But the x-ray ureteral catheter came into prominence in 1906 when Voelcker and von Lichtenberg<sup>1</sup> first used colloidal silver to outline the ureter for roentgenographic study. Bougies made from opaque substances are well known as diagnostic aids in defining fistulas.<sup>2</sup> However, so far as I can ascertain, no one has considered the use of opaque media of known shape and

aid in the roentgen delineation of thoracic fistulas.

The late Dr. Oliver Lyons first drew my attention to the possible use of the x-ray catheter in the diagnosis of diverticula of the bladder. In such cases, the catheter may be inserted into the diverticulum, and when it is coiled it will reveal the contour in three dimensions (Fig. 1). In spite of its rigidity this instrument is used extensively in the examination of the ureter and the pelvis of the kidney without injury to these delicate structures.

In the cited cases, the value of the catheter as a diagnostic aid, and some

<sup>1</sup> Braasch, W. F., and Hager, B. H. *Urography*. Ed. 2, Phila., Saunders Co., 1927.

<sup>2</sup> Fantus, B. *X-ray contrast media*. *J. Am. Pharm. A.*, 18: 231, 1929.

<sup>3</sup> Tuffier, T. The treatment of purulent pleural effusions. *Med. Rec.*, '96: 464, 1919.

\* Submitted for publication June 4, 1931.

indications for preferring it are demonstrated. In the first case it was also of therapeutic aid.



FIG. 3. Lateral view of chest showing x-ray catheter indicating direction forward and extent of fistulous tract associated with lung abscess. Type 2.

A young lady was referred to us for roentgenograms of the chest following an operation in which a dermoid cyst in the

no more could be done than to open the cyst and insert a drainage tube. The tube was in place between the fourth and fifth ribs anteriorly and came to the surface near the costochondral junctions. When we saw her, there was pus draining through the tube, she had fever and a cough, and raised sputum. There was a cavity in the base of the right lung with a fistula leading to the anterior chest wall at the right border of the heart. The problem was to reveal the contours of the cavity in its three dimensions, and the thickness of its walls. The usual method would have been to inject either bismuth paste or one of the iodine preparations. However, none of these seemed desirable because they would have obscured the wall of the cavity to some extent. Consequently, the x-ray catheter was introduced through the tract, and the roentgenograms revealed it coiled in the cavity as in Figure 2. This procedure was quite simple in technique and enabled the observer to study the size of the cavity in three dimensions and the character of its wall. Immediately after the catheter had



FIG. 4 A. Sinus in upper lumbar region with x-ray catheter in position. Catheter extends through opening in diaphragm as seen in Figure 4 B. Type 3.



FIG. 4 B. Lateral view of chest showing x-ray catheter extending from abdomen through opening in diaphragm and into pleural space along vertebral column.

base of the right lung was opened and a drainage tube inserted. She had been moribund at the time of operation, and

been removed, the patient coughed up a little mucoid material. Shortly thereafter, the drainage ceased, the fever subsided,

and the cavity healed. There has been no return during the past eleven years.

In the second case, the catheter enabled

ject a fluid or a paste, as the extent or possible communications of the fistulous tract were not known. The x-ray catheter



FIG. 5 A. X-ray catheter in cavity of thoracic empyema. Type 4.



FIG. 5 B. Same as Figure 5 A, patient rotated slightly



FIG. 6 A. Two opaque media of known contour in case involving more than one tract. Rubber tubing extends from opening in abdominal wall into stomach; x-ray catheter extends from same opening into region of gall bladder. Barium meal has been given by mouth to prove location of rubber tubing. Type 5.

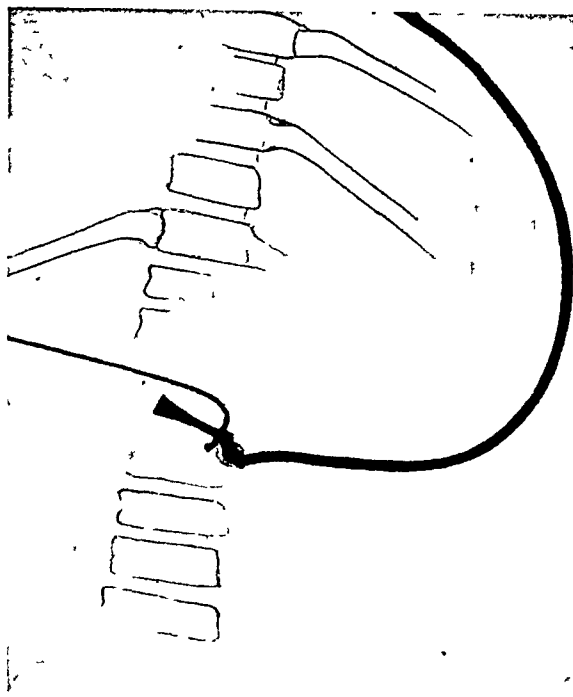


FIG. 6 B. Artist's sketch illustrating condition portrayed in Figure 6 A.

us to study the extent and position of the tract and surrounding structures with ease. The patient had a fistulous tract leading to the posterior chest wall at the middle of the vertebral edge of the right scapula. Again, it was undesirable to in-

was used, and I found that the tract led between the upper and middle lobes forward to the anterior chest wall (Fig. 3).

The third case was that of a woman who presented herself for examination because of a sinus in the left upper lumbar region.

use of various media aids in the differentiation. Case v illustrates this point. A twenty-two year old woman who had been operated



FIG. 7. Beck's paste has been injected from fistulous opening in lateral wall of abdomen, and has filled not only fistulous tract but pelvis of kidney and ureter also. Type 6, No. 1.



FIG. 8. Numerous ramifications of fistulous tract filled with Beck's paste. Type 6, No. 2.

She had advanced pulmonary tuberculosis of long standing, and the left kidney had been removed three years previously because of abscess. It was decided to explore the tract first with the ureteral catheter. The catheter followed the tract readily, upward past the former site of the left kidney, through the left dome of the diaphragm into the thorax, and along the posterior pleural space and the vertebral column (Figs. 4 A and 4 B). In this instance, the examination by means of the catheter was sufficient without the injection of a large quantity of other material and the coincident unpleasantness to the patient.

In thoracic empyemas, often it is difficult to fill the entire cavity without using a large amount of opaque material. In this, the fourth type of case, an opaque fluid or paste would have obscured the structures, but the catheter outlined the extent and position of the cavity very well (Figs. 5 A and 5 B).

In cases which have more than one tract, all having a common external opening, but each leading to a different organ, the

upon seven months previous for gallstones, was referred to us for examination of a discharging sinus that opened anteriorly above the umbilicus. She said that some particles of food and hot burning liquids passed out through the sinus at times. The barium meal showed the stomach pushed to the left side and the pylorus and duodenum negative. Some of the barium meal passed from the descending duodenum into the sinus and to the surface through it. When the x-ray catheter was inserted in the fistula it passed toward the gall bladder. A rubber catheter was inserted, and it entered the stomach by way of the duodenum as far as the cardiac end. A second barium meal outlined the stomach. Some of the barium meal then escaped alongside the catheter. Here, the injection of the usual medium into the fistula would have obscured the gall bladder and the stomach, and, certainly, the opaque media would have been inadvisable until we had surveyed the case by other methods of examination. Therefore two substances of known contour were necessary; in this case, a piece of rubber tubing and the x-ray

catheter. The latter entered the region of the gall bladder while the tubing indicated the opening into the duodenum (Figs. 6 A and 6 B).

In the sixth type of case, that in which there are tracts with numerous ramifications, the catheter is of no value. In such an instance, bismuth paste or iodized oil is the better injection medium, as is shown in Figure 7, where the injected Beck's paste filled the pelvis of the kidney and the ureter as well as the fistulous tracts. The use of the fluid medium is exemplified on a larger scale in Figure 8, a case in which the ramifications were so numerous that the opaque material almost filled the entire abdomen.

There is also another condition in which I suggest that the catheter might be of value, that is, the bronchoscopic examination of certain bronchiectatic and abscess cavities of the lungs. Dr. T. E. Carmody has found that it offers promise in this procedure.

## CONCLUSIONS

1. The x-ray ureteral catheter is a medium of known opacity and contour. An attempt is made to draw attention to its use as a simple though valuable diagnostic aid in the study of fistulous tracts,—a piece of apparatus ready at hand.

2. Its use is indicated in the injection of those fistulas whose distribution and location are unknown, and when it is therefore undesirable to use an opaque liquid or paste.

3. It is always desirable to study the tissue surrounding the tract or cavity, and the catheter obscures this less than the usual other media.

4. In cases presenting more than one fistulous opening the use of more than one medium of known contour permits ready and quick recognition of each tract, and aids in the differentiation of one from another.



## REFERENCES OF DRS. REGAN AND MENSING\*

1. BARGEN, J. A. Experimental studies on the etiology of chronic ulcerative dysentery; preliminary report. *J. A. M. A.*, 83: 332, 1924.
2. WEBER, H. M., and BARGEN, J. A. *Surg. Gynec. Obst.*, 50: 964-972, 1930.
3. BARGEN, J. A., and COMFORT, M. W. *Ann. Int. Med.*, 4: 122-123, 1930.
4. BROWN, J. Y. Physiological rest as applied to chronic ulcerative dysentery. *Surg. Gynec. Obst.*, 16: 610-614, 1913.

\* Continued from p. 55.



# FISTULA IN ANO

## ETIOLOGY: GENERAL CONSIDERATIONS\*

CECIL D. GASTON, M.D., F.A.C.S., AND MARSHALL D. HOGAN, M.D.

BIRMINGHAM, ALA.

UNSURGICAL procedures, injudicious packing and inadequate post-operative care, perpetuate fistula as an undisputed grief of surgery. Many times, we have observed the grooved director forced into an external opening, and through healthy tissue into the bowel lumen, in the belief that a fistulous tract had been successfully traversed. A fistula cannot be cured until the true internal opening is ferreted out in correct surgical fashion.

In our clinic, beginning November, 1927, and ending April, 1930, 667 major operations were performed upon the rectum. Of this number, 140, or 20 per cent presented fistula. Data, collected in this group of 140 consecutive cases, are illuminating. One hundred and eight cases are from the records of a large general hospital. Thirty-two cases are from the records of a select private hospital, and are of patients representing the upper stratum of the white race. Thus a cross section of afflicted society is presented for consideration.

To understand the etiologic mechanics of fistula, a concept of the embryologic and anatomic characteristics of the dentate margin is essential. This cryptic watershed between mucosa and skin, and splanchnic and somatic systems is histologically weak. It is exposed to continuous trauma and infection.

Among the general profession, belief exists that fistulae are tuberculous. This sentiment has been expressed frequently by physicians who were observing our work. It has been our experience that the prime consideration is a pathologic crypt. With few exceptions, we have not failed

to locate the internal opening in an anal crypt.

Our cases have been classified into the following etiologic groups:

1. In 105 cases, or in 75 per cent, the internal opening was revealed in a diseased crypt. Only 5 of this group presented a high internal opening; in each case the original opening was found in a crypt. A few cases presented involvement of two crypts, communicating through the main channel. Hemorrhoids of varying grades were found to be nearly constant. We believe that neglected hemorrhoids are an important predisposing source of infectious cryptitis. In this connection, it should be noted that the age incidence of hemorrhoids and fistula is practically equivalent, a point that may be invested with real significance for proctologic surgeons.

2. In 22 cases, or in 15.7 per cent, rectal stricture was the etiology. Many of this group presented multiple internal openings below the stricture that apparently resulted from minute trophic ulcers of anal canal. There was associated involvement of crypts in a number of cases. The negro race predominated in this group.

3. In 8 cases, or in 5.7 per cent, the internal opening was found in a perforated anal ulcer. It has been our experience that a perforated anal ulcer is more likely to result in a sinus than in a fistula. Because we have classified the so-called blind internal fistula as a sinus, we have eliminated it from this study.

4. In 4 cases, or in 2.8 per cent, trauma was the influencing factor. In this group, 2 cases developed during convalescence from hemorrhoidectomy; 1 case followed

\* Read before American Proctologic Society, 31st Annual Meeting, Buffalo, N. Y., June 22-24, 1930.

penetration of rectal wall by a fish bone; a fourth case followed injection of quinine and urea hydrochloride beneath the mucosa of a first degree prolapse. In many cases, histories revealed that attention was first directed to the rectum through a bruise or other trivial injury. These patients believed that they had sustained an injury to the rectum. Pathologic findings disproved their beliefs.

5. One fistula was encountered complicating a low adenocarcinoma.

Of the 108 cases from general hospital service, 14, or 12.9 per cent, presented evidence of an associated tuberculosis. Of the 32 select cases, 3, or 9 per cent, presented this evidence. This was furnished by tissue examinations, physical examinations, and roentgenograms of chest. We suggest that a careful check of 140 fistulous cases of graded social structure, with approximately 90 per cent, yielding no evidence of associated tuberculosis, presents substantial data for existing proof against tuberculosis as a causal agent. It is reasonable to conclude, that the rôle of tuberculosis in fistula, may be likened to that of syphilis, in that either of these, tuberculosis or syphilis, subjects tissues of fragile histologic structure to concomitant infections.

In the management of suspected tuberculous cases, operative technique has not been modified. We have never applied the cautery. We do not pack fistulous wounds. Postoperative incontinence has not been reported. Results have been gratifying.

Under general anesthesia with traumatic divulsion, location of an internal opening is a difficult feat. With sacral anesthesia, this act is accomplished accurately and readily. Easy breathing, cooperation, muscular relaxation, untraumatized tissue

and bloodless field invest the work with real enchantment. One per cent procaine is our routine. We obtain constant anesthesia with 35 to 40 c.c. in the caudal canal, 15 c.c. in each second sacral, 10 c.c. in each third sacral, and 5 c.c. in each fourth sacral foramen. We have found that more complete relaxation and more uniform anesthesia follow the foramina block. It is technically easy. Additional procedure consumes the time that would be passed in waiting for the anesthesia of caudal block alone. Induction is usually complete in seven to fifteen minutes. We have operated upon patients under regional anesthesia who, otherwise, would have been rejected as poor operative risks.

In the series of 667 operations, there were 102 caudals, and 484 combined caudal and foramina blocks. Eighty-one cases included spinal, circumanal and general narcoses in children. In only 14 cases of the group representing regional anesthesia, and then merely as a supplement, we have employed ether, gas or ethylene. There has not been a death that could be traced, either directly or indirectly, to the anesthetic. There were only three reactions that caused anxiety. Two of these were manifested by convulsions and unconsciousness. In one case, the block was being performed by an interne who had disregarded aspirated blood; the second patient proved subsequently to be a victim of epilepsy. One distressing sequel was reported in the form of intense sciatica. In view of a previous attack, this latter complaint was considered coincidental.

By reason of regional anesthesia, fistula technique has assumed, what we may be pardoned in calling, leadership in the art of surgery.



# INTERNAL HEMORRHOIDS

## THEIR PATHOGENESIS AND THE RATIONALE OF INJECTION THERAPY\*

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THE injection treatment of hemorrhoids has not been enthusiastically accepted by the American medical profession,<sup>8</sup> and others in the United States have recently written on phenol injection therapy of hemorrhoids. In January 1930,

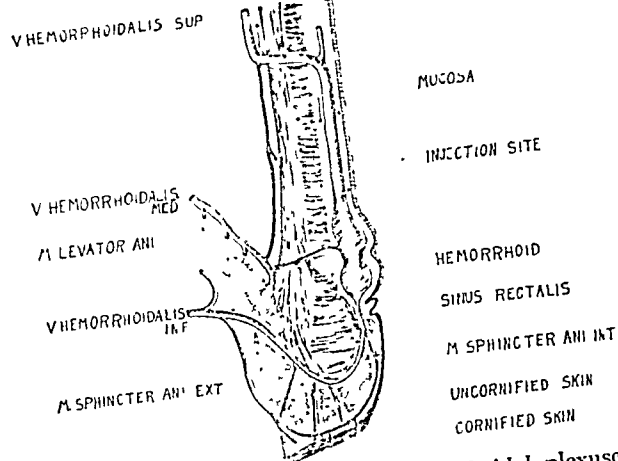


FIG. 1. Internal and external hemorrhoidal plexuses. Direction of blood flow when hemorrhoids are present and site of therapeutic injection.

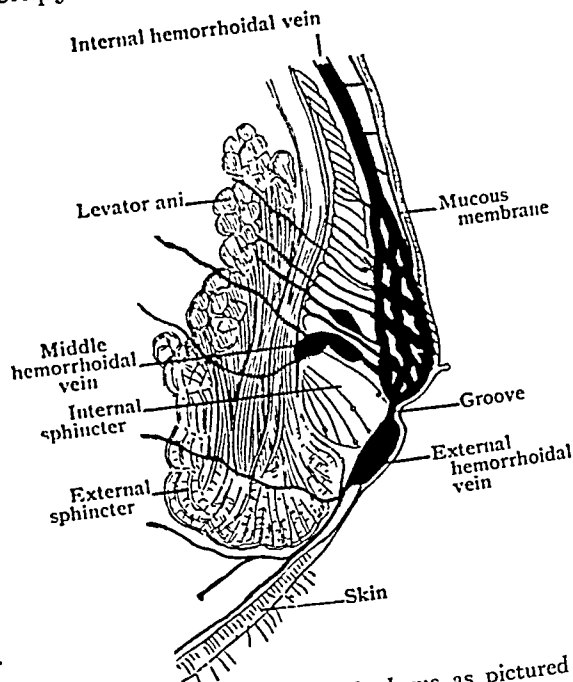


FIG. 2. Internal hemorrhoidal plexus as pictured by Otis. Compare with Figure 1.

profession largely because of its support by irregular practitioners plus the lack of standardization of technique and the consequent ill results. Numerous solutions have been advocated of which alcohol, quinine and urea, and various strengths of phenol in oil or glycerine have been the most popular. Boas<sup>1</sup> previously advocated the use of 96 per cent alcohol but recently<sup>2</sup> has reduced the strength of his solution to 70 per cent because of complications. Brockman<sup>3</sup> proposed an adaptation of either alcohol, phenol, or quinine and urea to the individual case. In 1918 Spencer<sup>4</sup> reported a death from liver abscesses and infarcts of the lungs following the use of quinine and urea. Anderson and Dukes<sup>5</sup> in 1924 reviewed the history of injection therapy and its controversies, and also studied the pathological effects of phenol injections. Montague,<sup>6</sup> Pruitt,<sup>7</sup> Gold-

while visiting at the St. Marks Hospital in London, the writer<sup>9</sup> observed a simplification of the phenol injection technique as employed by Mr. Gabriel and the results were so striking that anatomical studies were undertaken to determine the rationale of the therapy. The methods of study are reported elsewhere. The following survey and Figure 1 represent a summary of the investigations on hemorrhoids.

The hemorrhoidal veins are described by most modern anatomists as forming two plexuses (see Figs. 1 and 2): an internal, lying in the rectal submucosa and anal subcutaneous tissues, and an external, lying in the perirectal fat between the

\* Submitted for publication June 3, 1931.

muscular wall of the bowel and the fascia recti. The external plexus is drained by the middle hemorrhoidal veins which pass into the internal iliac veins. This plexus plays practically no rôle in the development of hemorrhoids because its communications with the submucous plexus are insignificant.

The internal hemorrhoidal plexus, which is the site of hemorrhoid formation, consists of two groups of veins in which the circulation normally diverges from the white line of Hilton. The inferior group passes between the anal sphincters to form the inferior hemorrhoidal veins, which after passing through the ischioanal fossae, terminate in the internal pudendal veins. Dilatation of this inferior group leads to the formation of external hemorrhoids. The superior group passes upward in the submucosa and pierces the muscular wall about 4 inches above the mucocutaneous junction. These vessels, after receiving communicating branches from the external plexus, form the superior hemorrhoidal vein which courses upward on the posterior surface of the rectum and terminates in the inferior mesenteric vein.

Thus it is seen that the veins of the internal hemorrhoidal plexus pass through two openings surrounded by muscle tissue, namely, the space between the internal and external anal sphincters below, and the hiatuses in the rectal wall above. The normal tonus of these muscles substitutes for the lack of valves in the superior and inferior hemorrhoidal veins. Reflux is thus prevented from the superior hemorrhoidal vein into the internal plexus under normal conditions.

When internal hemorrhoids are present, however, the circulation in the internal hemorrhoidal plexus is reversed. This fact may easily be demonstrated in the course of anal examination if one withdraws the anal speculum to the level of the white line of Hilton. Compression of the inferior route of escape in this manner will cause the internal hemorrhoids to enlarge progressively. This reversal of circulation

results from either of two factors: (a) compression of the veins at the points where they pierce the rectal wall, or (b)

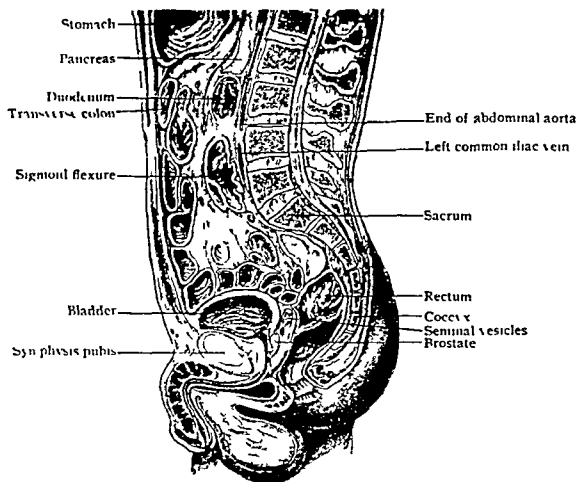


FIG. 3. Sagittal section of pelvis to show lumbo sacral angle in erect posture.

dilatation of these vascular hiatuses, allowing reflux into the internal hemorrhoidal plexus.

That portal congestion *per se* is not the sole factor in the production of this reflux is shown by the relative infrequency of hemorrhoids in cases of portal cirrhosis. The collateral anastomosis between the superior and middle hemorrhoidal veins takes place outside of the rectum and, unless the vascular hiatuses in the rectal wall allow reflux into the submucous plexus, this anastomosis probably carries the burden of the collateral circulation relegated to the hemorrhoidal veins. Sedentary habits and loss of tone of the rectal wall are probably greater factors than pure portal congestion in the etiology of hemorrhoids due to reflux. One need only recall the frequency with which one finds the rectum full of stool in patients suffering with hemorrhoids to appreciate that loss of tone with consequent dilatation of the vascular hiatuses is of much greater significance than hypertonicity with constriction of these hiatuses. In fact, the writer doubts that factors other than the infiltration of the rectal wall with tumor tissue or inflammatory exudate ever constrict the vascular hiatuses and produce hemorrhoids.

Other factors such as pregnancy and pelvic tumors, which produce pelvic congestion, impede the return flow by pressure on the pelvic veins. When the impediments have finally been removed, the vascular hiatuses have become dilated and reflux becomes possible.

Of equal significance is the additional load placed upon the return flow of blood from the submucous plexus into the superior hemorrhoidal vein by the sitting and slumping postures. These postures flatten the lumbosacral angle and steepen the grade of ascent for blood in the internal plexus. (See Fig. 3.)

In contradistinction to the relaxation of the rectal ampulla, spasm of the anal sphincters is a common clinical finding. Not only does this spasm interfere with the escape of blood from below when the circulation is reversed and internal hemorrhoids are present, but a similar effect is produced when the normal circulatory conditions prevail. Under the latter circumstances as well as under the former, predisposition to external hemorrhoid formation and thrombosis is produced. Thus it is seen that the common clinical findings of relaxation of the rectal musculature and spasm of the anal sphincters found in cases of hemorrhoids quite readily explain the existence of either internal, external, or externo-internal hemorrhoids.

#### INJECTION THERAPY

The technique used by the writer at the Michael Reese Dispensary in Chicago and at present being employed in private practice in Milwaukee is as follows:

Five per cent phenol in cotton-seed oil, a 5 c.c. Luer-Lok syringe, a  $2\frac{1}{2}$  inch 20 gauge needle upon which a necktie-pin safety clasp has been fitted to control the depth of the needle insertion, and a Kelly anoscope constitute the armamentarium. Five per cent phenol in oil has been studied by the writer and found to be self-sterilizing. The injections are made beneath the mucosa well above the hemorrhoid, as indicated in Figure 1. About

1.5 to 2 c.c. are injected above each hemorrhoid. One or two hemorrhoids should be treated at a sitting. It is well to treat the bleeding piles first. About five to seven days is a satisfactory interval between treatments.

It will be noted that this technique differs from that commonly recommended in that the injection is not made into the hemorrhoid itself, but well above the pile in an area free from ulceration and infection. The ill results such as necrosis, ulceration, oozing, abscess and temporary disability that have resulted from injections directly into the hemorrhoid are eliminated. Bleeding piles cease to bleed within a few days and the procedure is painless and without danger. The therapeutic effects equal those obtained from injection directly into the vicinity of the hemorrhoid. The resulting progressive induration that occurs about the veins high up prevents undue reflux and causes shrinkage of the hemorrhoid.

To be sure, one must exercise a degree of discretion in the application of any form of injection therapy. In cases of thrombosed, unusually large, or badly prolapsing internal hemorrhoids, operation should be given preference; although one is frequently surprised at the amount of prolapse which will be retracted by the proper execution of the technique. The writer has occasionally injected anal papillae to remove them by sloughing, but the patient must be warned of the pain that accompanies this injection. External hemorrhoids are not amenable to injection. The exclusion of carcinoma of the rectum, cirrhosis of the liver, pressure on the pelvic veins due to tumors, and other established etiologic factors is essential before instituting any type of hemorrhoid therapy.

#### SUMMARY AND CONCLUSIONS

Internal hemorrhoids are principally due to reflux into the hemorrhoidal plexus after dilatation of the vascular hiatuses in the rectal wall has occurred.

The sitting and slumping postures are predisposing causes to their development.

The injection of five per cent phenol in oil beneath the mucous membrane

of the bowel well above the hemorrhoid offers a safe and rational non-operative method of treating properly selected cases of internal hemorrhoids.

#### REFERENCES

1. BOAS, I. Ueber die Injektionsbehandlung Haemorrhoiden. *Med. Klin.*, Berlin, 18: 753, 1922.
2. BOAS, I. Eine kleine, aber wichtige Verbesserung meine Injektionsmethode der inneren Hämorrhoiden. *Deutsche. med. Wchnschr.*, 57: 225, 1931.
3. BROCKMAN, T. Observations made in treatment of 300 cases of hemorrhoids by injection method. *J. South Carolina M. A.*, 20: 247, 1924.
4. SPENCER, H. J. Fatal results following injection method of hemorrhoids. *J. A. M. A.*, 70: 222, 1918.
5. ANDERSON, H. G., and DUKES, C. Treatment of hemorrhoids by submucous injections of chemicals. *Brit. M. J.*, 2: 100, 1924.
6. MONTAGUE, J. F. The Modern Treatment of Hemorrhoids. Phila. Lippincott, 1926.
7. PRUITT, MARION C. Injection Treatment of Internal Hemorrhoids. St. Louis, Mosby, 1929.
8. GOLDBACHER, L. The Injection Treatment of Hemorrhoids and Pruritus Ani. Phila. Davis, 1930.
9. HILLER, R. I. The anal sphincter and the pathogenesis of anal fissure and fistula. *Surg., Gynec. Obst.*, 52: 921, 1931.



## SURGICAL TREATMENT OF PULMONARY TUBERCULOSIS\*

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THE sanatorium physician and tuberculosis specialist of twenty-five years ago had practically abandoned any idea that surgery would assist in the cure of tuberculosis. Operations on tuberculous patients were avoided, especially those involving the lung tissue and chest cavities. Today it is universally accepted that the surgeon and bronchoscopist are destined to take an increasing share in the treatment of advanced pulmonary tuberculous disease. The reason for this is quite obvious when one realizes that sanatorium treatment with all its accessories, aided by favorable climate and the necessary financial backing has had at best a bare 10 per cent recovery rate for the far advanced pulmonary tuberculous patient.

The introduction of artificial pneumothorax was a long step in advance and now it remains for the profession at large to accept the additional contributions of phrenicotomy, thoracoplasty and pneumolysis, which offer vastly more for tuberculosis than had been dreamed of twenty-five years ago. As late as 1925 only about 300 patients having pulmonary tuberculosis had been reported as having been operated upon by seventeen surgeons in the United States. During the period from 1918 to 1925 only 58 cases had been reported from the British Empire, 42 from France, 14 from Argentina, 2 from Italy and about 1200 cases from Germany, Scandinavia and Switzerland. These cases averaged 37 per cent actual cures with another 24 per cent decidedly improved.

Today, six years later, surgical compression has become a regular procedure in our tuberculosis institutions and at the present time it is estimated there are approximately 40,000 persons in this country, with

pulmonary tuberculosis who present suitable indications for surgery and who will die of their tuberculosis if they are not operated upon. During this same five-year period the improvements in care and technique have increased the favorable results to between 80 and 90 per cent.

The surgical therapy of pulmonary tuberculosis has followed many blind paths. Only during the past forty years have the modern procedures that compress the lung been in process of development. The order of this development has been: first, for many centuries drainage of tuberculous cavities; second, the direct medication of tuberculous lesions via the tracheal or intercostal routes; third, in 1858 Freund advanced a theory that apical tuberculosis was more common in persons whose first rib was shorter or whose first cartilage was stiffer than normal and as a remedy for a stiff narrow thoracic inlet Freund advocated a partial resection of the first cartilage in order to mobilize the apex and permit it to enjoy full respiratory exercises; fourth, pulmonary resection.

As frequently happens, while the surgical profession was groping about in its efforts to surgically aid pulmonary tuberculosis, a James Carson of Liverpool, more than a hundred years ago had enunciated the doctrines which finally laid the foundations upon which the entire structure of pulmonary compression therapy is built. As early as 1821 James Carson was urging the production of artificial pneumothorax. In abscess of the lung he pointed out that "the sides of the abscess are prevented from falling into a salutary contact, not by the matter which lodges between them, but by the powerful elasticity and retraction of the surrounding substance."

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It was not, however, until 1885 that the first operation to relax the tuberculous lung by attacking the overlying bony framework was undertaken by Cerenville of Lausanne. This was followed by several European surgeons modifying the technique in various ways. These costal resections were not, however, extensive enough to compress the lung sufficiently and it remained for Brauer and Frederick, of Hamburg, in 1907, to first remove sections of all the ribs from two to nine and thus obtain an actual pulmonary compression rather than a mere relaxation.

The first operations were highly dangerous. The shock was terrific, the chest wall fluttered, the mediastinal displacement was too great. Many modifications ensued—one, two or three stage operations—until finally Sauerbruch in Germany evolved that which is at present known as the modern paravertebral extrapleural thoracoplasty.

Other operations besides thoracoplasty have been in process of development for pulmonary tuberculosis. Among these are, extrapleural pneumolysis performed by Tuffier, intrapleural pneumolysis, ingeniously performed through a thoracoscope, by Jacobeus, phrenicotomy, resection of the second and third thoracic sympathetic ganglia, bone graft operation, fixing the chest wall by bony union, ligation of the pulmonary artery, evulsion of the intercostal nerves, and the resection of alternative ribs. From this brief review it may be seen that surgery for collapse of the lung has passed through many phases and its present satisfactory state is the result of numerous combinations of procedures.

Tuberculosis in any part of the body heals by fibrous encapsulation. To bring this about, individual resistance to the disease is the most important factor. The next most important is functional rest of the diseased part. Rest is the keystone of successful treatment of tuberculosis in any organ. Without compression treatment a diseased lung cannot be put at absolute rest. A deribbing operation on the chest

wall anatomically reduces the chest capacity, compresses the lung and paves the way for the following physiological changes: an increase in the blood supply, lymph stasis and the favorable formation of an increased amount of fibrous tissue. Pulmonary compression constitutes a "physiologic amputation." Stagnant secretions and products of degeneration are removed from the body and cease to form because of pulmonary rest. Subsidence of inflammation and encapsulation of the tuberculous lesion follows.

Various methods are devised for surgically producing this physiologic rest. The simplest operation is phrenicotomy. Phrenicotomy or phrenic nerve evulsion as the name implies, is the cutting or stripping out of the phrenic nerve through a small incision in the lower neck just above the clavicle. The operation is indicated: for failure of artificial pneumothorax, as a preliminary to thoracoplasty, as a sole measure where the opposite lung excludes the possibility of a thoracoplasty, in artificial pneumothorax cases where adhesions are causing trouble and increased pressure is contraindicated, in artificial pneumothorax cases with partial collapse, but a good functional result, (these are basal cases) in artificial pneumothorax to lengthen the refill, and in early cases. The dangers of phrenicotomy are wounds of cervical arteries and veins producing serious bleeding. The second and third procedures used in producing surgical compression are extrapleural pneumolysis and intrapleural pneumolysis. The closed intrapleural method of cauterizing and separating lung adhesions through a thoracoscope as practiced successfully by Jacobeus is greatly restricted by a number of important contraindications: the difficult technical maneuvers, the location of the adhesions and subsequent hemorrhage and infection with empyema.

The operation of choice is to produce a satisfactory surgical compression of the lung by attacking its bony framework. Although there are a number of modifica-



tions the operation most in use is that known as Wilms-Sauerbruch extrapleural paravertebral thoracoplasty. The indications for this procedure are found in patients in good general condition who have clinically one-sided, chronic, advanced, fibrous, cavernous or non-cavernous tuberculosis without complications, who have failed to respond to a sufficiently long sanatorium regime, and a combination of phrenicotomy and attempted artificial pneumothorax. In these patients thoracoplasty offers an 80 to 90 per cent chance of cure or improvement. Also patients with severe persistent tuberculous or mixed empyemas with or without bronchial fistula. Further, cases in which a small lesion in the better lung has not progressed while a partial artificial pneumothorax has been used on the poor side. Cases in which the lesions in the worst lung are not predominantly fibrous but are mostly caseous, pneumonic and progressive. Finally that type of case which contains multiple cavities and ulcerative lesions in which a good pneumothorax controls the disease. The destructive type of tuberculosis is more apt to be accompanied by empyema and surgical compression should be instituted before this occurs.

The contraindications against thoracoplasty are: cardiovascular disease, bone or joint tuberculosis, severe laryngeal tuberculosis, severe kidney disease and intestinal tuberculosis. Few patients over forty-five are suitable.

The operative procedure is performed under local anesthesia. A two-stage operation is selected; during the first stage, the sixth to eleventh ribs are resected subperiosteally from the vertebral joint to beyond the angle of the rib. After a two to three weeks' interval there follows a second stage with resection of fifth, third, second, first and fourth ribs in order. The fourth rib is allowed to remain in position until the first rib has been resected. The amount resected in each rib varies slightly with the size of the patients but approximates these measurements:

1st rib—3 cm.

2nd to 5th rib—5 to 8 cm.

6th to 8th rib—12 to 15 cm.

9th to 11th rib—12 to 6 cm.

The first rib must always be partially resected; otherwise collapse is only partial. The eleventh rib tends to keep the lower chest from falling in and should be resected.

The patient, female, aged 27, normal weight 120 lb., 5 ft. 2 in., married and with two children of twenty-two months and six weeks respectively, had always enjoyed good health except while at college when she would become run down during the spring months. At these times examination revealed nothing except mild anemia.

While in the hospital, December 27, 1926 upon her third day post-partum she developed a dry pleurisy. X-ray examination of the chest was negative except for some pleural adhesions to the left diaphragm which were interpreted as old. Her post-partum convalescence was poor. She became exhausted and her general health failed.

One month later January 28, 1927 she developed influenzal pneumonia with signs of a much thickened pleura posteriorly at the left base. Repeated thoracentesis with large caliber needles revealed no fluid. She was severely ill at home for two months with persistent, productive cough and fever of 101 to 103°F. During April her cough lessened, fever was slight, pulse slower and she gained weight. On April 26, x-ray examination revealed a marked left pleural density up to the fifth interspace. The lung parenchyma in the lower lobe could not be made out definitely but showed a marked bronchial infiltration. The upper lobe showed no parenchyma involvement. The heart and mediastinum were displaced to the left. The right lung and pleura were negative. Sputum examination made at intervals, from the beginning of her illness showed no tubercle bacilli.

During May, 1927, she suffered an acute exacerbation of symptoms and began to cough, expectorate profusely and lost 12 lb. in weight. She was then sent to Thomas Hospital and remained there for seven months. While there she was x-rayed several times and no further findings could be discovered except that the left pleura was denser and her heart and mediastinum were further displaced. There

was some suspicion of parenchymal thickening in the left apex. The right lung was clear except for bronchial infiltration. Many sputum examinations for the presence of the tubercle organism were made but were negative. Bacteriologic studies of fluid from thoracenteses were also negative.

The first two months of hospitalization were stormy and surgical treatment was considered. However, she began to show signs of improvement, took on weight, felt and looked better. By February 1928, she weighed 144 lb. and was permitted to go home. Her general condition then improved so steadily, that in June she was up and about. The only symptoms of note at this time were dyspnea on exertion, and irregular periods lasting three to five days every two weeks, when she coughed a good deal and ran a slight fever and accelerated pulse rate. During these exacerbations her throat became sore. Tonsil tags on both sides were considered as possible causative factors and were removed August 1928.

Hopes were held for complete recovery without surgical intervention but when the season changed, her condition became the worse. After the first frost that fall she again showed symptoms and returned to bed. In January, 1929, in the course of one of her periodic remissions she became severely ill with temperature, 102 to 104°F., pulse 132 to 140, marked dyspnea, severe pain in left chest and purulent productive, stubborn cough. For three weeks her condition was critical but she rallied as she had often done before and she began to improve. However, surgical measures were definitely decided upon. She was accordingly sent to the hospital where x-rays revealed the same density in the lower left chest as noted before and in addition, a small but definite lesion in the upper left apex. This was interpreted as a recent tuberculous involvement. The right lung and pleural cavity were

essentially negative. Two sputums were found positive.

A primary phrenic nerve exeresis was advocated by two consultants to be followed by a radical thoracoplasty if no definite improvement occurred. On April 24, 1929 11 cm. of the left phrenic nerve were evulsed. Following this procedure her cough became markedly lessened and she showed some clinical signs of improvement. Roentgenological comparisons as to whether or not the left diaphragm was actually elevated was a matter of conjecture due to the apparent massive pleural adhesions. The clinical results as shown by her progress the next two and one-half months were not so favorable as was desired. Every effort was made to make her the best possible surgical risk, and on August 12, 1929, the first stage of a two-stage extrapleural thoracoplasty was performed. Her postoperative progress was very satisfactory. On September 14, 1929 the second stage was done. She remained in the hospital until Oct. 3, and in bed at home for another six weeks.

The postoperative complications in the order encountered are shock, mediastinal shifting, paradoxical respiration, hemorrhage, cough and retained secretions, massive collapse of the opposite lung and infection. None of these were present in this case.

Her health since then has steadily improved; she now weighs 145 lb., looks and feels well. Continued observation for at least six months, preferably one year, under the care of an internist, is the best aftercare. It is two years since her thoracoplasty and she shows no signs of any further involvement.

This case is reported with the view of stimulating interest of rehabilitating a patient who has had tuberculosis over a long period of time and apparently seems beyond recovery.



# CHOICE OF ANESTHESIA<sup>\*</sup>

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THE entire history of anesthesia goes back only about ninety years. America is the birthplace of anesthesia; to this country belongs the honor of having first discovered and then publicly demonstrated this boon to suffering mankind. The names of Crawford Long, William Morton and Horace Wells are all too familiar to our readers for us to dwell upon their connection with the history of anesthesia.

Ether was first used in 1842 and publicly demonstrated in 1846. Nitrous oxide was first used in 1844. Chloroform was first used in 1847 and ethyl chloride in 1848. Thus within the short period of six or seven years the general anesthetics which we have been using for the past eighty years were brought into being.

Local anesthesia is much more recent. Very little knowledge of its use existed before the latter part of the 19th century and the beginning of the 20th century. The real use of local anesthesia dates to very recent times. Local anesthesia even today is probably in its infancy.

Spinal anesthesia was first accomplished by Corning in 1885, using cocaine, but to Bier belongs the credit of having first intentionally produced surgical spinal anesthesia. This was done in 1899. Jonnesco and Babcock must receive the credit for keeping this type of anesthesia alive until it could be made more popular by the recent work of Labat and Pitkin. To the latter two must be given the prestige of popularizing spinal anesthesia.

More recent developments in the anesthesia field include avertin and sodium amytal. These have been introduced during the past three years. Ethylene was first used by Dr. Arthur Dean Bevan in this country. This was in 1923. So much for the synopsis of anesthetic history.

The actual selection of the best anesthetic for a given type of patient and given type of pathological condition is, as a rule, not difficult, but occasionally, is a very hazardous affair.

It is unquestioned that the most important person connected with the surgical operation is the patient himself. The surgeon is under obligation both to the patient and to himself to avail himself of every known thing that modern science has to offer to minimize the risk of the operation. In the recent past we only had a choice between ether, chloroform, and nitrous oxide with oxygen, and each patient and his surgical condition had to accept one or the other of these. We are in a more fortunate position today and we must exercise judgment and care to give the patient the best available anesthetic. Our choice today lies between ether, chloroform, nitrous oxide, ethylene and local anesthesia, which include spinal anesthesia, and the basal anesthetics, sodium amytal and avertin. All of these have special usefulness. The day of a routine anesthetic has passed; the anesthetist of the past has become a back number. No longer can one who is proficient only in the administration of inhalation anesthetics be called a first class anesthetist.

We can no longer make the patient fit the anesthetic, but must fit the anesthetic to the patient and pathology at hand.

To approach the indications for the different types of anesthesia it is easier to take up each one separately. I am quite aware that the indications herein stated will seem rather conservative to one who acts and thinks more radically, and will, at the same time be looked upon by the ultra-conservative as most radical.

<sup>\*</sup> Submitted for publication June 6, 1931.

## SODIUM AMYTAL

This preparation was first introduced into surgery by McCallum of Indianapolis three years ago. It was to be injected intravenously. I have never seen anything put a patient to sleep as quietly and as quickly as this preparation when injected intravenously. It enjoyed a sporadic popularity for a few months, but has generally been considered as unsafe when given intravenously. However, it does have a field of usefulness. It has been extensively used of late in the dose of 6 to 12 grains two hours before operation and is given in 3 grain capsules by mouth. In this way morphine has, to some extent, been replaced. In other words, it is now looked upon, not as an anesthetic, but as an hypnotic. It belongs to the barbiturates, such as luminal and veronal. Its field of usefulness is principally in conjunction with local anesthesia in any of its forms, although it is used extensively in conjunction with nitrous oxide and ether for abdominal work. In the latter it reduces the quantity of inhalation anesthetic necessary. There are no contraindications to its use (except idiosyncrasy), but it has two disadvantages, or better, untoward reactions. After the operation patients are very apt to have a lowered temperature (2 or 3 points) and they frequently become irrational just before they come out from under its influence.

## AVERTIN

This preparation has been used for the past four years. Chemically, it is tribromomethyl alcohol. It is always given by rectum in a 3 per cent solution and in the dosage of 80 to 120 mg. of the crystals to each kilogram of body weight and it is given one-half hour before operation. Its action is very rapid. The patient passes quietly into the unconscious stage without any struggling. The maximum stage of anesthesia is reached in about twenty minutes and it lasts from four to six hours. Complete anesthesia can be obtained, but

it is desirable only to obtain unconsciousness from which the patient can be aroused and then supplement this anesthesia with nitrous oxide, ether or local anesthesia. In other words, avertin is to be used only as a basal anesthetic and not as a full surgical anesthetic. Its special field of usefulness is for operations about the head, neck and chest. A cautery may be used with safety. It will, no doubt, completely replace ether-oil-colonic anesthesia because of its simplicity of administration. It is also useful for extremely nervous patients in that they are put to sleep in their own bed and awake after the operation is over, with no memory of the trip to the operating room and the period of waiting in the anesthetic or operating room.

It is absolutely contraindicated in four conditions:

1. Hepatic disease, including jaundice of all types, but not gall-bladder disease.
2. Acute nephritis or other diseases of the kidney in which its function is seriously interfered with.
3. Local rectal irritation of any type.
4. Acute pulmonary disease and active tuberculosis.

Both sodium amytal and avertin cases require intelligent nursing service until reaction occurs and for this reason their use will be restricted.

## ETHYLENE

This preparation is a gas and is administered in the same manner as nitrous oxide. It is an excellent general anesthetic and stands between ether and nitrous oxide from the standpoint of muscle relaxation. It does not have the same deleterious effect on the heart and blood vessels as does ether and nitrous oxide and does not irritate the kidneys as does ether. Were it not for its explosiveness it would probably be the safest and most satisfactory general anesthetic. Its explosive properties may have been exaggerated and statistics are now being gathered to try to show that it is no more explosive

than ether and nitrous oxide. This is a very serious matter and until some more positive method of preventing its explosion can be found it is wise to take no chances. I have always had an uneasy feeling when I happened into an operating room in which it was being used.

#### LOCAL ANESTHESIA

There are three forms of this type of anesthesia, differing in the method of induction:

1. Local Infiltration, that is the injection of the anesthetic solution directly into the tissues of the field of operation.

2. Regional field block, the injection about the nerve roots going to a special part of the anatomy and at a distance from the field of actual operation.

Examples: Brachial plexus block, cervical plexus block, paravertebral block of thoracic or lumbar nerves.

3. Spinal block, the injection of the local anesthetic into the subdural space and its admixture with spinal fluid and thus anesthetizing the nerve roots in their intradural position.

The indications for use of local anesthesia in any of its forms are not easy to state because it depends on two variable factors, (1) the psychic state of the individual, and (2) the skill of the surgeon in the induction of local anesthesia. It is a very common observation that the surgeon who is skilled in the administration of local anesthesia uses it for many cases for which the indication does not appear clear cut. In other words, the more skillful one becomes in its administration the more frequently it is used.

In general the indications for local anesthesia may be stated as follows:

1. For operations of a very minor nature: warts, moles, sebaceous cysts, etc.

2. For surgery of patients of advanced age. They do not, as a rule, react as well under inhalation anesthesia.

3. In advanced dehydration states as seen in intestinal obstruction (acute and

chronic), hemorrhage, shock, prolonged illness associated with pyrexia.

4. When acute pulmonary pathology exists, whether the operative procedure is aimed at the pulmonary lesion or at some unassociated lesion.

5. For operations in patients having metabolic disorders involving the glands of internal secretion: diabetes mellitus and thyrotoxicosis.

6. When there is some other pathology which makes inhalation anesthesia hazardous: acute nephritis, myocarditis of advanced degree, hypertension.

Because of the fact that local anesthesia is so much in use today I am going into its field of use in a more specific way.

Local infiltration anesthesia: this has such a varied field of usefulness that a complete list of all the operations performed under it would be tiring. Almost any operation in the body can be done under this form of anesthesia when every other form may be contraindicated. It is not a good form of anesthesia for any operation in children. Fortunately we seldom have to give serious thought to anesthesia in children for they react very well to any of them except local.

Since regional field block and spinal anesthesia have been perfected the field of usefulness for infiltration anesthesia has become limited.

Regional field block anesthesia is particularly useful for the following operations:

1. Rib resections for empyema: anesthesia of the nerve along the rib to be resected and in addition the nerve above and below. This is best done about 4 cm. from the spinous processes.

2. Thyroidectomy: in this instance the second, third, and fourth cervical nerves on both sides are injected at their exits from the spinal foramina. This obviates injecting into the field of operation and also allows painless traction on the gland. It does more than give surgical anesthesia for it anesthetizes the upper two of the cardio-accelerator nerves on each side and thereby causes a slowing of the heart rate,

a very important point when one is operating for thyrotoxicosis. The operation is made technically easier than under inhalation anesthesia because the latter causes venous congestion of the veins of the neck and thyroid gland. Preliminary hypnosis (luminal grains 10 or sodium Amytal grains 9 or avertin) or narcosis (morphia) should be used in addition.

3. Tonsillectomy: when because of any contraindication to ether, regional block of the superior and inferior poles gives excellent anesthesia. A more perfect dissection is usually possible than when ether is used. I do not advocate its routine use, and, in fact, employ it in a very small percentage of cases.

4. Brachial plexus block: that is the injection of the solution underneath the fascia covering the brachial plexus. This produces excellent anesthesia and can be used for operations on the arm distal to the insertion of the deltoid muscle. Its particular usefulness is for amputation for diabetic gangrene of the fingers and in operations on patients who are not fit subjects for inhalation anesthesia. The more minor operations can be done under infiltration anesthesia instead.

5. Paravertebral anesthesia: the injection of the nerve roots on either side of the spinal column will allow any operation to be done on the chest or abdomen. For operations below the diaphragm spinal anesthesia is easier of accomplishment and more satisfactory, but it is an excellent method for thoracic operations, other than breast amputation.

#### SPINAL ANESTHESIA

The introduction of the solution into the subdural space of the spinal canal. The introduction is accomplished through a lumbar interspace (second, third, or fourth), below the termination of the spinal cord. The perfection of this form of anesthesia has been one of the great advances in surgery during the past five years. It has become the routine anesthesia for certain

operations in the majority of the great clinics in this country.

#### Indications:

1. Intestinal obstructions of all forms.
2. Prostatic and other bladder trouble.
3. Urinary extravasations.
4. Surgery on diabetics.
5. Surgery on the tuberculous.
6. In presence of acute respiratory diseases associated with acute abdominal disorders.
7. Major amputations of the lower extremities.

To those who are spinal anesthesia-minded the field is much broader. Some use it routinely for all operations below the diaphragm. It does have many points of advantage in surgery of the abdomen. The principal advantage is the relaxation of the abdominal wall and contraction of the intestines. It has been colloquially said that the abdominal wall is obliterated by its use. Of course, relaxation of the abdominal wall and contraction of the intestines make for easier operating and the avoidance of trauma by retractors and by gauze packs. Most intra-abdominal operations can be done under spinal anesthesia without the necessity of placing any abdominal pads. This is naturally reflected in the lessened number and character of postoperative adhesions and the abdominal relaxation is reflected in the smaller number of incisional hernias. Therefore, in addition to the actual indications for its use, spinal anesthesia has special usefulness for the following conditions:

1. Rectal work, hemorrhoids, fistula, tumors, etc. The rectal sphincter rarely requires any dilation because it is so relaxed.
2. Perineal and vaginal operations.
3. Surgery of the intra-abdominal female reproductive organs.
4. All major genitourinary surgery.
5. For treatment of fractures of the lower extremities, whether closed or open reductions, or debridement of compound fracture. Muscle relaxation allows an ease

of reduction that cannot be appreciated unless seen.

6. For any operation below the diaphragm requiring as much as an hour and a half to complete. Radical operation for cancer of the stomach, small intestines or colon.

The question of heart disease and spinal anesthesia can be summarized by stating that when ether and nitrous oxide are contraindicated, then spinal anesthesia is indicated. This rather broad statement needs some explanation, however. A patient with decompensation of the heart muscle cannot breathe with the head lower than the feet; in fact, a prone position may not be compatible with life. In these cases a heavy solution must be used so that the patient's head and shoulders can be raised. The question of choice of anesthesia in these cases is hazardous at least.

With regard to the blood pressure and spinal anesthesia we can give spinal anesthesia for lower abdominal operations with a systolic reading as low as 80 or 90, but it should be at least 100 systolic for upper abdominal operations. A very high pulse pressure, that is, when the pulse pressure equals or exceeds the diastolic pressure, is a bad risk for spinal anesthesia, but these cases can be taken safely through the procedure with due care on the part of the anesthetist.

There are actually few contraindications to the use of spinal anesthesia but they are absolute. These are three in number:

1. Infections in the region of the site for lumbar puncture. It matters not how slight the infection, even a pimple must be absolutely respected.

2. General septicemia, a positive blood culture should not be the deciding factor. If negative it does not mean that you can assume septicemia to be absent. A clinical septicemia is sufficient contraindication.

3. Cerebrospinal: tuberculosis, syphilis, meningitis, tumors, turbid fluid regardless of its cause.

Relative contraindications to the use of spinal anesthesia are: (1) shock, (2) blood

pressure below 90 systolic, (3) operations above the diaphragm.

Spinal anesthesia has no irritating effect on any of the vital organs. The kidneys, lungs, liver, heart and brain are unaffected; in fact, the heart is more apt to have a period of rest while the patient is under the effect of the solution.

#### OTHER USES OF ANESTHETICS

Aside from the surgical uses of the anesthetic or hypnotic preparations mentioned in this communication, there are particular fields for their usefulness in medicine and for diagnosis and obstetrical deliveries. Avertin or sodium amytal are useful in the treatment of tetanus, strychnine poisoning, rabies, meningitis, gallstone and ureteral colic, gastric crisis, delirium tremens, status epilepticus and wherever sleep and relaxation become a necessity. Avertin has been recommended for controlling eclamptic convulsions, but because of the associated liver or kidney damage, or both, it must be regarded as unwise inasmuch as both of these conditions contraindicate its use. We have used sodium amytal intravenously to produce hypnosis in postoperative pain or insomnia. We can also theoretically see a field of usefulness in certain of the excitation types of insanity.

Type of Anesthesia	Times Used
Nitrous oxide with ether.....	14
Nitrous oxide alone.....	40
Spinal Anesthesia.....	22
Avertin—with either gas or local.....	14
Local infiltration or field block.....	15
Chloroform.....	2
Ether-oil colonic (Gwathmey).....	1
Sodium amytal preliminary.....	5

The position occupied by nitrous oxide and ether is still of major importance and

in an average general surgical service one of these would probably be used more frequently than any of the newer forms. This can be best illustrated by a glance at the table shown on page 76 which represents a total of 113 anesthetics given during a ten-week period on a public ward service (Drs. Taggart and Johnson).

#### CONCLUSION

It might be well to emphasize that all of the work being done today on the anesthesia question is in answer to the state of dissatisfaction that has always existed

about the known anesthetics. We are searching for an ideal anesthetic. There probably never will be such a thing for the simple reason that routine has no place in anesthesia. We will, no doubt, have better anesthetics than we possess today, but we will never reach the stage where all types of patients and the pathology that they present can be made to fit any one type of anesthesia. We are men of science, not artisans, and we will always be confronted with the same problem so aptly stated by Pottenger, "There is a patient who has the disease as well as the disease which has the patient."

#### REFERENCES

- |  |   |
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| <p>EVANS, C. H. Spinal Anesthesia. N. Y., Hoeber, 1929.</p> <p>FARR, R. E. Practical Local Anesthesia. Phila., Lea &amp; Febiger, 1923.</p> <p>GUTTMAN, J. R. Rectal anesthesia with tribromethyl alcohol. <i>Am. J. Surg.</i>, 10: 70-72, 1930.</p> <p>HOLMAN and PALMER. Sodium isoamylethyl barbiturate as an auxiliary anesthetic. <i>AM. J. SURG.</i>, 10: 55-59, 1930.</p> <p>ISENBERGER, R. M. Pharmacological action of sodium amytal. <i>AM. J. SURG.</i> 10: 35-53, 1930.</p> <p>JOHNSON, V. E. Spinal anesthesia. <i>AM. J. SURG.</i>, 11: 478-484, 1931.</p> | <p>LABAT, G. Regional Anesthesia. Phila., Saunders, 1923.</p> <p>LABAT, G. The trend of subarachnoid block. <i>S. Clin. North America</i>, 10: 671, 1930.</p> <p>PITKIN, G. P. Controllable spinal anesthesia. <i>J. M. Soc. New Jersey</i>, 24: 425, 1927.</p> <p>REED, C. B. Avertin anesthesia in obstetrics. <i>AM. J. SURG.</i>, 10: 76, 1930.</p> <p>SPEIDEL, F. G. Avertin basal anesthesia. <i>AM. J. SURG.</i>, 10: 73-75, 1930.</p> <p>SHERWOOD-DUNN, B. Regional Anesthesia. Phila., Davis, 1921.</p> <p>WATERS and MUHLBERGER. Tribomethanol anesthesia. <i>Arch. Surg.</i>, 21: 887-897, 1930.</p> |
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# ELEPHANTIASIS OF THE SCROTUM

## OPERATIVE TECHNIQUE\*

JAMES I. KNOTT, M.D., AND JUSTUS B. RICE, M.D.

FIRESTONE PLANTATIONS, LIBERIA, WEST AFRICA

**E**LEPHANTIASIS of the scrotum is primarily a disease of the skin. The tumor consists of a hard bark-like

be kept in bed before operation, for when the mass is supported, the fluid in the tumor drains upward and invades the skin



FIG. 1, Case 1. Position of patient on table with feet supported on chairs.



FIG. 2, Case 1. Patient five days postoperative. Thiersch grafts on shaft of penis.

layer of dense hypertrophied skin, enclosing a mass of blubbery, fluid-distended, areolar tissue. In this mass are the penis and testes. The penis is always in the upper part of the mass near the pubis. The testes are deep in the mass and are held there by the gubernacula. The skin of the prepuce and the shaft of the penis have been drawn forward over the glans and form a skin-lined tube from the glans to an external opening on the front of the tumor mass. There is usually a definite palpable demarcation between the normal and the elephantoid skin.

The most suitable case for operation is a large tumor with a long pedicle of normal skin which can be utilized for flaps to cover the shaft of the penis and to reconstruct the scrotum. The patient should not

to be used for flaps and obscures the palpable edge of the elephantoid skin.

The case which has no pedicle is more difficult. One must remove all the involved skin even though there is not enough left for flaps. The causative agent of the disease, the filarial worm, is in the elephantoid tissue. The basic principle is to remove the worm-bearing tissue. A good working hypothesis is that the disease is an inflammatory or urticarial irritation from the worm and its secretions. It is much easier to explain the good results from operation on this basis than on one of lymphatic obstruction. If the testes are not greatly enlarged by hydroceles, one can dissect up the skin of the thighs on each side of the perineum and get enough skin to cover them. In dealing with filarial

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hydroceles, one should excise the whole sac for the filaria are in the sac wall. Thiersch grafts are very satisfactory for

mass to the opposite side one gets beautiful exposure of the field, and escapes the awkward handling and lifting of the tumor



FIG. 3, Case 11. Large elephantiasis of scrotum, weight, 130 lb



FIG. 4, Case 11 Tumor removed. Penis under skin of abdomen with only glans exposed.



FIG. 5, Case 11 Final result

covering the shaft of the penis, and give a very good immediate cosmetic and functional result. These grafts will take in 100 per cent of cases if done at the time of operation. One should remove all the loose areolar tissue and graft directly on the bare fascia of the penis. Dress with vaseline gauze.

Hemorrhage, shock from too prolonged operating time, and infection, are the undesirable complications to guard against. The most helpful factor in preventing these, is the position of the patient on the operating table. The patient lies on a horizontal table with his legs over the sides and his feet supported on chairs. By rolling the

that is so troublesome and unavoidable with the lithotomy position.

The patient is under local, spinal, or rectal ether anesthesia. The skin has been scrubbed with soap and water. On the table it is painted with 5 per cent tincture of iodine and the field draped with sterile linen. The limits of the elephantoid skin are marked with a shallow knife cut. The first incision is a vertical one over the pubis down to the rectus fascia. The penis is dissected out, working down from its base to the glans. The skin lined tube beyond the glans is clamped across and divided between two hemostats. This frees the penis and it can be brought up onto the abdomen. Next

each cord is picked up at the external ring and followed down to the testes. These are freed by cutting the gubernacula. Hydroceles are very frequently present, also hernias. Repair them at this stage. So far only one incision has been made and the field is still sterile. Often the entire operation can be done without cutting into elephantoid tissue. Next deepen the skin incisions along the preliminary knife mark. Cut only through the skin. Then one finds a cleavage plane and the skin flaps can be turned back with very little bleeding. Dissect the flaps well back onto the thighs in the perineum and several inches onto the abdomen above the pubis. Starting over the lower abdomen, cut the attachment of the tumor cleaning off everything down to the bare fascia of the lower abdomen and the bare muscles of the urethra and the perineum. Take care not to open the urethra or the rectum. If no ragged tabs of tissue are left, healing is very prompt even though infection and suppuration should occur. Place the testicles in the perineum one in front of the other instead of side by side, and tailor the skin flaps to cover them properly. Close with a double line of interrupted catgut sutures. Dress daily. Drain if indicated.

Another technique for covering the shaft of the penis when there is not enough good skin for flaps, is to place the penis in a tunnel under the skin of the abdomen. The glans is brought out through a small incision. At a second operation under local anesthesia, the penis is freed.

These patients are potent and every testis should be conserved no matter how flattened or worthless it appears.

The large cases with the tumor weighing 50 to 75 lb. are spectacular, but most of one's cases will be the early ones in which the patient is having periodic attacks of elephantoid fever and swelling. During an acute attack, the entire scrotum and the skin of the shaft and prepuce are hot and swollen and have all the appearances of cellulitis and lymphangitis. Do not operate during an acute attack. The swelling will partially subside after the temperature goes down. Save enough of the skin of the scrotum to cover the testes but remember that the less of this skin that one leaves the less are the chances of recurrence. Thiersch graft the penis. If this is the only focus of filaria, the patient will be cured.

#### SUMMARY

The operative procedure for elephantiasis of the scrotum is described. The most important feature is the position of the patient on the table. The patient lies on a horizontal table with his legs hanging over the sides and his feet supported on chairs. Rolling the tumor to the opposite side gives good exposure and obviates handling or lifting the tumor. The penis and testes are dissected out through an incision over the pubis and the operation is usually completed without cutting into elephantoid tissues.



# SUBUNGUAL EXOSTOSES

## REPORT OF TWO UNUSUAL CASES\*

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IN 1926 certain observations in regard to these interesting growths were reported.<sup>1</sup> Since that time 60 more cases have

son to the number noted upon the bones of the feet, the number noted upon the hands is negligible, personal records show but



FIG. 1. Early cartilagenous stage of subungual exostosis, clinically well developed.



FIG. 2. Fully ossified subungual exostosis, clinically occupying most of nail bed.

been seen, making a total of 102 cases, all of which with the exception of two have been operated upon, with this amount of material to study certain facts have become more apparent.

1. *Distribution*: The greater number occur on the large toes, as a unilateral condition; so far not a bilateral case has been seen; they have been noted upon all of the other toes except the fifth, but in no instance has more than one been noted on the same individual. These growths are apparently limited to the pedal digits, no case has been personally observed nor to my knowledge reported affecting the fingers. This would seem to bear out a clinical fact that in general exostoses are more often seen on the lower than on the upper extremities, in compari-

three, these were in the same location, viz: in the middle of the edge of the articulating surface of the first metacarpal bone directly beneath the tendon of the flexor pollicis.

2. *Anatomic location*: They occur either on the tibial side of the distal phalanx or in the center, few exceptions to this rule occurring. One of these cases is reported in this paper.

3. *Etiology*: In our former series we were suspicious of infection playing a rôle in certain cases, but in this latter group there has been a uniform history of trauma, this has been so uniformly present that we believe it to be the paramount if not the only factor in the determination of these growths. That an individual tendency toward exostosis formation exists seems plausible, as all cases of trauma to the great toes do not develop exostoses. Clinically, it would seem that a similar predisposition exists in the formation of exostoses other than the one under discussion. That short or ill-fitting shoes play

<sup>1</sup> Kurtz, A. D. Subungual exostoses. *Surg., Gynec., Obst.*, 43: 488-490, 1926.

\* From the Orthopedic Department, Jefferson Medical College, Phila. Submitted for publication August 31, 1931.

a part is very doubtful, as all of these patients have a distinct remembrance of a specific accident.

present, reenforced by a mallet, leaving the smaller cavities to granulate and packing the larger ones for a period of forty-eight



FIG. 3A.



FIG. 3B.

FIG. 3. Case 1. Subungual exostosis.

4. *Sex:* The female has predominated in the ratio of 5:1, that the clumsiness of dancing partners is a prominent factor is borne out by the number who report that the toes were heavily trodden upon while dancing. Other accidents such as dropping heavy articles upon the toe or having the toe trod upon while in public vehicles or places are common.

5. *Age:* The period of life given over to social and athletic activities is the time that most of these growths occur.

6. *Treatment:* That the treatment is definite and that cure is certain is shown in this last series of cases; there has not been a single recurrence noted. Removal under local anesthesia by a small gouge, occasionally if well marked ossification is



FIG. 4. Case 11. Subungual exostosis.

hours is all that is necessary. There is no excuse for general anesthesia, wide exposure and consequent mutilation; some cases have been seen in which this was done and the end result has been anything but satisfactory.

Two cases are appended to show (1) the size of the mass and its long duration in the one and (2) the location and size in the other.

CASE 1. L. W., aged twenty-six, single, housemaid, German, in America about one year, remembers that while dancing eight years ago with a large and heavy male, he trod upon the right great toe. The reaction was severe causing total disability for two

weeks. Shortly thereafter, without complete cessation of the tenderness, the nail became troublesome, this was treated by several practitioners for ingrown nail, the entire nail being removed several times, with no relief. The growth which had appeared soon after the onset of the trouble continued to grow, but time after time was passed by as having no bearing upon the discomfort and disability. The growth was removed by the usual technique fifteen months ago. There was rapid healing, and no recurrence of either the pain or the growth.

*Comment:* It seems almost unbelievable that some one, in eight years' time, had not radiographed the toe or awoke to the realization that it was not a nail condition.

CASE II. M. S., female, white, single, house duties, American. Trouble began eight or ten years ago following the dropping of a heavy weight upon the right great toe. Pain was on the lateral side of the great toe, accompanied by local tenderness. The nail has been removed twice in this time for ingrown nail. The entire end of the toe is enlarged, there is a reduplication of the normal lateral soft tissues of the nail margin, this reduplication being free at the proximal end, giving the appearance of fleshy tumor, attached at its distal extremity. The entire mass is bony hard and tender. The shoe has been worn "cut-out" over the

mass for the past two years. X-ray showed an exostosis originating from the lateral (fibular) side of the phalanx, extending laterally and mushrooming at its free end. Under local anesthesia a gouge was entered between the free skin and the toe, pushed forward and toward the phalanx until the latter was reached. A mallet was necessary to complete the removal en masse, with the overlying soft tissues, the nail not being disturbed except on the lateral edge. The cavity was packed for forty-eight hours. Granulation then occurred, and three months later the toe had resumed its normal aspect and was painless.

*Comment:* Immediate radiography solved a problem that at first presented some doubt as to the diagnosis, and there is no question in my mind that had the toe been radiographed several years before that the diagnosis would have been made and considerable suffering saved the patient.

Experience has taught that in a case of pain and tenderness involving a toe, particularly the large one, that immediate radiograph, unless the case is plainly evident, should be taken. In the early cases some confusion may arise because ossification has not occurred, but if these toes are radiographed in two planes fewer diagnostic errors will occur.



# ATONY OF THE BLADDER

## REPORT OF A CASE\*

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THE relief of obstruction of the neck of the bladder has as its object the restoration of the urinary function so that spontaneous urination is reestablished with the resulting relief of symptoms, the cessation of the residual urine and the resulting clearing up of the infection. Whether the obstruction be due to lateral lobe hypertrophy, bars or contractures the objectives mentioned here are obtained. Occasionally a few pus cells remain in the urine, or a dram or two of residual persists for a short time as well as a slight frequency of urination, all of which are minimal and generally clear up with after-treatment.

Failure of urination to become reestablished so that the patient must again use a catheter, with the prospect of a catheter-life before him, is an occurrence of great rarity. The factors that contribute to this failure, such as an overlooked middle lobe, a diverticulum, an overlooked stone or an overlooked carcinoma of the prostate, are the relatively common causes, but to review them here would be unnecessary since they were not present in our case.

The failure of urination to reestablish itself so that postoperative retention resulted, can be explained in one of three ways: (1) That the operation failed in that the obstruction was only partially or incompletely removed; (2) that some overlooked lesion of the central nervous system was responsible for the patient's present condition, or (3) that the patient's present condition is due to atony of the bladder, due to disease of the bladder muscle itself.

In a patient under the care of one of us (H. L. K.) this problem was pres-

ent. The obstruction had been completely removed as subsequently proved by autopsy. A very careful examination of the central nervous system before and after operation failed to demonstrate the presence of organic disease of the central nervous system. Because of the relatively great rarity of this occurrence it seems desirable to report the following case.

### CASE REPORT

W. D., male aged seventy-seven years, married, referred by Dr. Donald P. Abbott, admitted to the Presbyterian Hospital of Chicago, May 6, 1928.

*Previous History.* Negative, usual childhood diseases.

*Family History.* Negative.

*Present Complaint.* Shortness of breath on exertion for four months. Swelling of the right leg, ankle to knee, for ten years. These symptoms came on gradually; they have never become so severe as to preclude the patient from performing his usual occupation.

*Urinary Symptoms.* There were no urinary symptoms. At rare intervals the patient is obliged to void once and sometimes twice at night. No frequency, dysuria, hesitation, urgency, dribbling, or trouble in stopping or starting the stream. A normal quantity of urine was invariably passed. Forty years ago, during an attack of dysuria, he passed brick-dust urine which lasted only a few days. Since that time he has never exhibited any symptoms.

*Physical Examination.* Head, neck and lungs, negative. Heart, left border extends slightly beyond the midclavicular line; the right border is within normal limits; a soft blowing murmur is heard at the apex; the heart rate is 84 and the rhythm regular.

*Abdomen.* Protrusion more forward than lateral, particularly manifest in the lower

\* From the Presbyterian Hospital and the Thompson Urological Fund of Rush Medical College of the University of Chicago. Submitted for publication April 11, 1931.

portion of the abdomen. A region of suprapubic dullness extending from the symphysis to the xyphoid and within three fingersbreadth of either iliac spine is present. The patient lying on his right side discloses six fingersbreadth of tympany on the left side. Because dullness was so high and extended so far laterally with shifting tympany on the sides indicating the clinical picture of an ascites, the differentiation between ascites and such an enormous bladder retention was called for, especially on account of the absence of urinary symptoms. In order to exclude ascites a catheter was passed, demonstrating that we were dealing with an over-distended bladder and not with an ascites.

*Spleen.* Not palpable. Liver, dullness normal.

*Rectal Examination* (H. L. K.). The sphincter tone is good. The prostate is broad and flat. No evidence of lateral lobe hypertrophy. Seminal vesicles palpable.

*Neurological Examination* (Dr. D. P. Abbott). Pupils, equal, regular and react to light and accommodation. The plantar and achilles reflexes, normal. The knee-jerks, equal and normal. No ankle clonus. Babinski sign, negative. Pain, thermal and touch sensation of the lower extremities, normal. No disturbance of deep muscle sense.

#### *Blood Examination.*

Red cells.....	4,200,000
Leucocytes.....	18,000
Hemoglobin.....	80 per cent

*Blood Pressure.* Systolic 168; diastolic 112

#### *Blood Chemistry.*

Urea nitrogen.....	19.4
Uric acid.....	7.3
Creatinine.....	3.2
Non-protein nitrogen.....	43.2
CO <sub>2</sub> combining power.....	45.8
Blood sugar.....	95.2
Blood chlorides.....	509.0

*Wassermann and Kahn Tests.* Negative.

*Urinalysis.* Reaction, alkaline, albumin 0, sugar 0, blood 0, leucocytes per cubic millimeter, 300. Cultures *B. coli communior* and *Staphylococcus aureus*.

*Electrocardiogram.* Hypertrophy of the left heart with slurring and notching of the Q. R. S. phase.

*Fluoroscopy* (Dr. D. P. Abbott). Stomach in a very marked transverse position as if it were pushed up. Fluoroscopy of the colon: the upper portion of the rectum compressed

and the sigmoid narrow for a distance of 2 or 3 in. The remaining bowel negative.

*Roentgen-ray Examination of Chest.* Negative except for calcified glands in the left hilus.

*Catheterization.* A No. 12 French catheter was passed into the bladder and 2½ oz. of urine withdrawn every hour for the first twenty-four hours and then 3½ oz. every hour for the following eight days. In other words, gradual decompression was carried out over a period of eight days before the bladder was finally empty.

*Cystoscopic Examination* (H. L. K.). The cystoscope encounters an obstruction at the bladder neck which is somewhat edematous, this, no doubt, being caused by the indwelling catheter. A median bar is seen, behind which, on the right side in the region of the right ureteral orifice, the opening of a small diverticulum is seen. There is a very generalized trabeculation.

A second cystoscopic examination, a few days later, verified these findings.

*Operation* (H. L. K.), June 28, 1928 (sacral anesthesia). Suprapubic cystotomy. The bladder was enormously thickened, the walls measuring about ¾ in., extended midway between the umbilicus and xyphoid. It was opened in the usual way, but it was difficult to see the entire interior because the walls "kept falling" into the cavity. The bladder neck was open and the prostatic urethra was felt to be large. The median bar was resected and the prostatic urethra again explored, but nowhere could any signs of intraurethral lateral lobe hypertrophy be found.

*Postoperative Course.* Uneventful. Patient was discharged, August 10, 1928.

*Subsequent Course.* Following the operation, the patient was never able to urinate and an indwelling catheter had to be used. On August 20, 1928, he was again cystoscoped but no obstruction at the bladder neck was seen. Left the hospital a few days later with an indwelling catheter which he continued to wear until his death, four months later, due to an influenzal pneumonia.

*Autopsy* (C. Apfelbach), *Anatomic Diagnosis.* Marked sclerosis of the coronary arteries with calcification; multiple scars of the wall of the left ventricle; marked hyperemia and edema of the lungs; right hydrothorax; huge dilatation of the stomach; marked hypertrophy of the wall of the urinary bladder; superficial



diverticula of the urinary bladder; scar of the prostatic portion of the urethra; edema of the interureteric ligament; extensive fibrous pericystitis; left hydroureter; senility; Paget's disease.

*Description of the Urinary Organs.* The maximum circumference of the fundus of the urinary bladder is 50 cm. and from the top to the beginning of the prostatic portion of the urethra 37 cm. No obstruction in the penile portion of the urethra. The prostatic portion is slightly curved, the convexity being to the left. There is a scar in the back wall of the prostatic portion of the urethra where it joins the urinary bladder and the maximum circumference at this point is about 20 mm. At the junction of the urethra with the bladder there is a thin light gray area of scar tissue the result of the operation. The interureteric ligament averages about 1.5 cm. in diameter on the left side and 1 cm. on the right. A diverticulum is seen in the back wall, its opening oval,  $2 \times 1$  cm., and the lower margin is 2 cm. superior to the opening of the left ureter. There are other superficial pouches in the wall of the urinary bladder, one at the fundus admitting the tip of the index finger.

The left kidney has been reduced to a huge hydronephrotic shell. The kidney substance averages 6 to 7 mm. in width everywhere. No obstruction at the mouth of the left ureter. The right ureter is not dilated. The right renal pelvis, however, is large. The width of the cortex and the medulla of the right kidney is 15 mm.

#### DISCUSSION

The clinical picture as well as the subsequent course of this case was unusual. The patient came to the hospital with no urinary symptoms; but on examination marked chronic retention was discovered. Thorough examination revealed no clinical evidence of central nervous system disease. At the time of operation great care was taken to remove all of the obstruction, and that this was done was proved by the autopsy. The bladder neck easily admitted three fingers. Following the removal of the median bar, the patient was unable to urinate. Similar cases, in which operation for possible prostatic

obstruction failed to remedy the retention, are reported by Asch, Walker, Geraghty and Casper.

Two theories may be presented to explain the failure of the operation to re-establish normal urination: (1) a muscular lesion, (2) a nerve lesion. In favor of the former is the fact that no evidence of central nervous system disease could be found although examinations were made with the object of trying to explain the chronic retention on a neurological basis. There may have been some disease of the peripheral nerves; but would this persist for so many years without showing some signs that could be recognized clinically? Is it not possible that an obstruction extending over a period of years with such marked retention would produce so severe a degree of muscle atony that even though the obstruction was removed, the bladder muscle would lose all its power of contractility? Furthermore, arteriosclerosis, so well defined in other parts of the body, as in this case, might produce changes in the bladder musculature that would cause a decided chronic retention or atony.

#### SYNONYMS

Various terms have been used to describe this clinical entity, among which one may mention, primary atony of the bladder, atonic bladder, idiopathic dilatation and atony, essential atony, and non-prostatic urinary retention, all of which terms describe a definite clinical entity of urinary retention, entailing neither the involvement of the central nervous system nor the mechanical obstruction to the outflow of urine. The fact that an obstruction was present and was operated upon, may modify to a certain degree the term used to describe the case under discussion.

#### REVIEW OF THE LITERATURE

With a wider knowledge of the subject of urinary obstruction, due in part to the development of modern diagnostic methods, a review of some of the earlier reported cases will undoubtedly institute

the inquiry as to whether some of them really belong to this group, it being possible, perhaps highly probable, that some of the earlier reported cases of so-called true atony were caused by other lesions. This statement is made because in the reports of earlier cases the significance of posterior valves of the urethra, as well as the significance of contractures and bars at the internal urethral orifice, was not fully appreciated as factors in the development of chronic retention. Without an attempt to review all the cases in the literature, brief reference may be made to some of the authors who have contributed to this subject.

James Paget, in 1868, reported the case of a child four years of age afflicted with hypertrophy of the bladder in which there was no obstruction, and he suggested that the condition was caused by a temporary closure of the urethra from contraction of the compressors which did not relax at the time the detrusor and abdominal muscles contracted. This disagreement in musculature coordination occurred in adults; it was designated as a "stammering bladder." Guyon, in his description, offered another explanation, stating that atony of the bladder was caused by a decrease of the life energy of the organ. This condition, he thought, resulted either from a chronic intoxication or from premature wear and tear of the organ, which may not necessarily arise from an arteriosclerotic process.

According to Zuckerkandl, it is not definitely known whether retention of urine, in the absence of mechanical obstruction and central nervous system disease, is an atrophic or degenerative change of the bladder muscle; hence, it is not definitely known whether the atony is caused by disease in the peripheral nerves.

Shattock's opinion is unusual. This holds that atony of the bladder may be a congenital lesion, which he likens to idiopathic dilatation of the esophagus, stomach, or colon. Asch reports 11 cases of bladder atony in which neither mechani-

cal obstruction nor involvement of the central nervous system was present. He states that trabeculation of the bladder is a dominant characteristic. Primary degeneration of the bladder musculature either from disease of the nerves in the bladder wall, or in the ganglia themselves, is the cause, he thinks.

Of still a different opinion is Walker, who describes the cause to be a lesion situated in the sympathetic reflex center of the hypogastric and hemorrhoidal plexuses. With but two exceptions, where the symptoms commenced after the age of forty, the majority of the 9 cases reported by him, revealed symptoms beginning under the age of thirty. Furthermore, a difference is noted between atonic trabeculations and trabeculations from urinary obstruction. In the former, the trabeculations are characterized by extreme fineness, regular branching, while the apex of the bladder remains relatively free; in the latter, the muscle ridges manifest thick and branching irregularities which sometimes involve the entire bladder.

Bransford Lewis says that all so-called unaccountable atonies of the bladder are the result of incomplete diagnosis. Physical obstruction or a disturbance of the nervous mechanism controlling urination should be held responsible for the causation where other causes are lacking.

Geraghty regards the etiology as a peripheral neuritis. Some of his recorded cases failed to show evidence of a cord lesion in the post-mortem examination. In a case of atony, reported by Smith, this condition was a post-diphtheritic complication.

Two distinct types of nerve lesions of the urinary tract are cited by Braasch:

- (1) Where definite clinical evidence of involvement of the central nervous system, denominated "cord bladder," is present;

- (2) Where there is no disease of the central nervous system, the lesion apparently involving the terminal nerve supply only. This latter condition known as

atonic bladder is again divided into two types: (1) atony caused by motor disturbance, (2) atony resulting from motor and sensory disturbance. Braasch further observed a similarity in the cystoscopic picture of atonic bladder to spina bifida occulta bladder. Differential diagnosis in the case of bladder atony or slight prostatic obstruction, as well as in doubtful cases of contracted bladder neck, may cause confusion.

In his study of the motor and sensory mechanism in 3 cases of bladder atony, Moore discovered an increase in bladder capacity with consequent loss of muscle tone and contractility, the sensory response varying from normal to complete anesthesia.

Fronstein's conclusions in 6 cases of bladder atony were that the condition might be caused by arteriosclerosis or secondary infection or local disturbance of the peripheral nerves.

Wilson, Mallard, Tattersall, Vassalo, Stutzin and Gundrum were unable to explain the etiology in their several reports.

In the case reported here the following facts presented themselves.

1. Repeated neurological examinations revealed no evidence of central nervous system diseases.

2. A preoperative diagnosis of median bar obstruction was made and at operation

a median bar was found and completely removed; but the removal of the bar failed to reestablish urinary function and the patient led a catheter life.

3. The autopsy findings revealed an enormous atonic bladder with no obstruction to account for the complete retention. In view of the fact that this patient had been operated upon, a careful search was made, at the time of the autopsy, to see whether or not a mechanical obstruction persisted, and with this object in view the urethra was opened up and careful search instituted for the presence of valves in the deep urethra as well; but none were found.

4. At the time of the autopsy the pathologist at once called attention to the greatly dilated and atonic bladder, a fact that was emphasized at the operation. A considerable part of the bladder kept falling into the wound during the operative procedures, and it was only by clearing the field that the operation could proceed.

5. Since no disease of the central nervous system could be found, in all probability, the chronic distention caused by the obstruction which was removed at operation led to a loss of tone and contractility of the bladder. Even after the obstruction was removed spontaneous urination was not reestablished because of the permanently damaged bladder muscle.

#### REFERENCES

- ASCH. Die Erkrankungen der Blasenmuskulatur. *Deutsch. med. Wchnschr.*, 35: 1293, 1909.
- BARRINGTON. Affections of micturition resulting from lesions of the nervous system. *Proc. Royal Soc. Med.*, 20: 20-27, 1927.
- BARRINGTON. The nervous mechanism of micturition. *Quart. J. Exper. Physiol.*, 8: 33-71, 1915.
- BARRINGTON. The central nervous control of micturition. *Brain*, 51: 209-220, 1928.
- BRAASCH. Data with regard to lesions of the nerves of the urinary tract. *J. Urol.*, 13: 383-398, 1925.
- CASPER. Ungewöhnliche Fälle von dauernde Hernverhaltung. *Deutsche med. wchnschr.*, 36: 385, 1910.
- CASPER. Lehrbuch der Urologie. Ed. 3, Berlin, Urban & Schwarzenberg, 1921, p. 261.
- ELLIOTT. Innervation of the bladder and urethra. *J. Physiol.*, 35: 367-445, 1906-7.
- FEARNSIDES. Innervation of bladder and urethra. *Brain*, 40: 149-186, 1917.
- FRISCH und ZUCKERKANDL. Die Nervösen Erkrankungen der Harnrockre und der Blase. *Hand. d. Urol.*, 2: 777, 1905.
- FRISCH und ZUCKERKANDL. *Hand. d. Urol.*, 1: 720, 1904.
- FRONSTEIN. Die Primäre Harnblasenatonie. *Ztschr., f. Urol.*, 23: 445-450, 1929.
- GERAGHTY. *J. A. M. A.*, 69: 1326, 1917.
- GUNDNUM. Familial bladder atony. *J. A. M. A.*, 78: 411, 1922.
- GUYON. Prostatisme vesicle. *Ann. d. mal. d. org. génito-urin.*, 65: 1889.
- LANGLEY and ANDERSON. *J. Physiol.*, 19: 71, 1895.
- LEWIS, B. Studies in obscure forms of prostatic obstruction and vesical atony. *Ann. Surg.*, 61: 276-290, 1915.
- MALLARD. Idiopathic atony of the bladder. *Texas State J. Med.*, 21: 362-363, 1925.

[For Remainder of References see p. 100.]

# RESECTION OF ARSENICAL EPITHELIOMA. PLASTIC RECONSTRUCTION OF HEEL\*

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THE occurrence of epitheliomata in psoriatic patients has been noted for many years. For a long time many

a review of the cases reported up to his time, concluded unequivocally that there were no known epitheliomatous forms of



FIG. 1. Character of original lesion in markedly hyperkeratotic skin.



FIG. 2. Method of application of cast with window cut for examination of pedicle.

dermatologists contended that this coincidence was indicative of a causal relationship between the two diseases. However, in subsequent studies this controversy appears definitely to have been determined in the negative by the consensus of those qualified to express opinions. Wile<sup>1</sup> after

psoriasis. He was also of the opinion that most of the cases which developed epitheliomata had some previously existing epithelial disorders and that arsenic was the most potent individual factor in predisposing to the appearances of epitheliomatous lesions in patients suffering from psoriasis. Though Hutchinson<sup>2</sup> has been given credit for first calling attention

\* From the Service of Dr. Harry Finklestein at the Hospital for Joint Diseases. Submitted for publication June 12, 1931.

## Milch—Epithelioma

to the relationship between the exhibition of arsenic and the appearance of epithelial neoplasms, an earlier observation appears



FIG. 3. Microscopic section (110X) showing epitheliomatous changes with typical "pearl" formation.

to have been made by Paris.<sup>3</sup> The latter noted in an industrial district that the tin burners and copper smelters were "occasionally affected with a cancerous disease of the scrotum," that "cows and horses lost their hooves and developed cancer of the rump, and that vegetables in the neighborhood of the smelters were affected."

Though this clinical observation, since confirmed by many others, was made as early as 1825, the actual mechanism of arsenic action in the production of epitheliomata has, of course, never been explained. Most authors have held the opinion that the arsenic *per se* was merely a predisposing factor rather than the direct etiological agent in the production of epitheliomatous growths. A number of other factors such as trauma, exposure to sunlight, x-ray, etc. have by them been considered as the precipitating causes of the malignant changes in tissues made more susceptible by the previous effects of arsenic. The recent excellent work of Osborne<sup>4</sup> has thrown some light on this

question. As a result of careful microchemical studies of tissues by a perfected method of his own, he was able to demonstrate that the occurrence of the arsenic in quintavalent as well as in trivalent form was not only of chemical but also of biological importance.

The arsenic in quintavalent compounds [such as Fowler's and Donovan's solutions] had a special affinity for structures of ectodermal origin, such as the epidermis, sweat and sebaceous glands and their ducts, hairs and hair follicles, and relatively less affinity for the blood vessels in the corium. The arsenic in trivalent compounds [such as arsephenamine] had a special affinity for the vascular structures such as small arterioles, and capillaries below the papillae, etc. Quintavalent arsenicals frequently produce pigmentation, keratoses, mild dermatitis, wrist drop and optic atrophy whereas trivalent arsenicals produce severe dermatitis, hemorrhagic encephalitis, and purpura . . . I feel that the logical explanation for the development of epitheliomata is that the bulk of the arsenic is developed in the papillary and sub-papillary layers of the skin. It has been shown by Bing and Schulz that action of arsenic in the body is one of the oxidation and stimulation of cells. If that is the case, stimulation of the basal layer might well offer the explanation for the formation of epithelioma.

In the case observed by us practically all of the factors which have been considered as responsible for the development of malignant changes have been present. In addition to a history of long continued use of arsenic, our patient was subjected to infra-red and ultraviolet light, to chemicals both bland and irritating, to radium and the x-ray as well as practically everything else that has ever been suggested in the treatment of psoriasis. The question may well arise as to whether any one or rather the combination of any of these factors may not be considered the directly responsible agent. That the x-ray or radium alone was probably not the direct cause is evidenced by the fact that neither the tumor-bearing area nor any of the other portions of the skin

previously exposed to the x-ray showed even the faintest suggestion of telangiectasia. On pathological examination of the

involvement of the lymph nodes three years after the appearance of the tumor. However, though his case had enlarged lymph



FIG. 4. End result. Showing extent of graft and character of healing along suture line.

specimen, likewise, there was no evidence suggesting the probability of a cancer developing on the basis of excessive exposure to the x-ray. On the contrary, the picture presented was that of the typical squamous-celled epitheliomata which Ewing classified under the acanthomata.

This type of tumor, the squamous-celled epithelioma with typical pearl-formation, has invariably been reported by other observers of this condition. For the most part the appearance of this new growth has been looked upon with great foreboding because of its apparent malignancy. Several cases have been reported in which apparent involvement of the regional lymph glands took place. In a case reported by Sutton,<sup>5</sup> the clinical history somewhat resembled the one herewith presented. There was apparent in-

nodes, no metastases were subsequently demonstrated, and Sutton observed, "It is said that this form of cancer does not affect lymph nodes." To what to attribute the innocuous character of what is ordinarily thought to be an extremely malignant tumor, we do not know. That the epitheliomata, like other tumors, vary in malignancy is a known fact. Broders<sup>6</sup> attempted to classify epitheliomata of the skin on the basis of the degree of their cellular differentiation. He determined four categories, in each of which the malign nature of the tumor decreased with the increase of adult stigmata in the cells. In this sense, the appearance of typical pearl-formation is to be considered as indicative of the assumption of adult characteristics and of proportionately better prognosis. It is quite likely that the

very processes of arsenic stimulation, which have been held responsible for the appearance of the epithelioma, may *pari passu* lead to early cornification and consequently restraint of tumor growth. It is this which probably justifies the clinical classification of arsenical epitheliomata as a separate subdivision of the larger group of epidermoid carcinomata. In the case herewith presented, the ulcerating area on the heel which was subsequently proved to be epitheliomatous in nature had persisted for about eight years without any evidence of metastasis or any evidence of local recurrence following excision.

W. J. male, white, aged forty-nine, was admitted to the Hospital on April 24, 1929 complaining of a chronic ulcer on the plantar surface of the left heel which had resisted treatment for a period of over eight years. While it is impossible to give the complete details of his long and varied therapeutic history, it will be interesting to know something of the course the case pursued over a period of some thirty years. During this long time he had been under treatment both here and abroad by various persons ranging in qualification from that of humble chiropodist to physicians of international reputation. During the first year of the disease he received local treatment with chrysarobin and mercury ointments and exposure to the x-ray. Between 1900 and 1921, when the ulcer on his heel first developed, he had intermittently taken Fowler's solution in doses of from 5 to 15 drops three times daily. Between 1917 and 1919, in addition to the usual local treatment he was given injections of autoserum and blood, and neosalvarsan both intravenously and intraspinally. About 1920, he developed an ulcer on the ball of the right foot which apparently yielded to treatment by ointments and powders. In 1921, a somewhat similar ulcer developed on the left heel. From the time of its appearance until he was first seen by Dr. Finklestein, he received x-ray, radium, ultraviolet, infra-red and gamma-ray light treatment without any local improvement. At times the ulcer appeared to be well on the way to healing, when again without apparent cause it would break down.

Apart from the local dermal manifestations, the patient appeared to be in good health and

the physical findings were relatively normal. On the third and fourth fingers of the left hand there were two ulcers lying in markedly fissured hyperkeratotic skin areas. The soles of both feet were covered by a thickened, rough, desiccated, fissured, hyperkeratotic skin. On the plantar surface of the left heel there was an ulcer about 2 inches in its largest diameter (Fig. 1). The floor was covered by apparently healthy looking red granulation tissue, and throughout it were scattered elevated islands of tissue covered by a thick epithelium. The edges of the ulcer were indurated and steep but showed no gross evidence of malignancy. There were no signs of any involvement of the inguinal glands. The laboratory examination of the urine showed about 1 mg. of arsenic in the total twenty-four hour specimen. The stool and sputum were negative. The hair which was markedly grayish was unfortunately not examined for arsenic contents.

Because the likelihood of malignancy did not suggest itself to us, and because we felt that possibly the healing of this ulcer had been delayed by weight bearing, it was decided to strap the ulcer area with adhesive and observe the progress after a two week period of bed-rest. When examined at the end of this trial period there was still no evidence of progress toward healing, and it was finally decided to excise the ulcer area *in toto*. On May 9, 1929, under general anesthesia, the skin and subcutaneous tissue over the plantar surface of the heel, extending from just behind the calcaneocuboid joint to the back of the heel and up on the sides of the foot for a distance of about 1.5 cm., was excised *en masse*. The tissue covering the os calcis was examined and found to be soft, pliable, and easily bleeding. A pattern of the skin removed was then made in paresine gauze and outlined on the anterior surface of the right thigh. Making an allowance for possible shrinkage, a pedicle flap with its base on the outer side of the right thigh was cut and raised. The wound on the right thigh was somewhat diminished by undercutting. The gap left in the thigh was covered by large Thiersch grafts taken from higher up on the thigh and the wound was protected by a paresine gauze dressing. The left heel was then flexed and brought over to the anterior surface of the right thigh. The edge of the flap was sutured into position, along the plantar surface, the inner surface, and half of the posterior surfaces

of the heel. A plaster-of-Paris cast was applied extending up the right leg and including the whole of the left leg for the purpose of immobilizing the left foot in its position on the anterior part of the right thigh (Fig. 2).

The patient made an uneventful postoperative recovery and apart from 0.6 gm. of sodium thiosulphate which was given intravenously every third day, to expedite the elimination of arsenic, needed no unusual postoperative care. On May 9, to our great surprise the pathologist reported the findings on the specimen removed in the following sense: "Nature of Specimen: Ulcer of Heel. Gross: Specimen consists of heel and part of the sole. On the heel there is a large ulcer about 4 cm. in its greatest diameter. Microscopical: Section shows a fully malignant epithelioma infiltrating the corium. Diagnosis: Epithelioma of heel of foot." (Fig. 3). Three weeks after the first, a second operation was undertaken for the purpose of cutting the pedicle flap. Under general anesthesia a large window was first cut in the plaster cast and a tourniquet applied to the base of the flap to determine the adequacy of the circulation. After about ten minutes, though there was a faint bluish tint in the skin of the graft, the circulation was considered sufficient to warrant severance of the pedicle. The cast was entirely removed and the flap of the pedicle cut through and sutured in place. To absolutely insure against the possibilities of a local recurrence, a section of the supracalcaneal tissues was removed and examined. This was reported on May 29, by the pathologist to show "numerous foreign body giant cells in a rather acute inflammatory process. No evidence of malignancy." The patient again made a completely uneventful recovery except for the appearance of a small triangular area of necrosis on the outer side of the heel where the base of the flap had been cut through. This gradually closed over and on July 17, 1929, the patient was discharged walking on his newly constructed heel. (Fig. 4.) Since that time the patient has been able to pursue his normal occupation without any interference whatsoever.

We may be pardoned for calling attention to the choice of procedure in this case, because we believe that the reasons for this choice are apparently of general applicability. It will be noted that a pedicle skin graft was undertaken instead of a whole thickness free graft. It must be

admitted that the latter method has certain advantages. It may be completed in a single operation, the immediate result is much neater in appearance, and the danger of infection is lessened. *Per contra*, the increased likelihood of success, by insuring adequate nutrition to the graft, more than compensates both the physician and the patient for the inconvenience and danger involved in the two-stage procedure. Though this type of graft necessitates the use of a cumbersome and annoying cast to secure thorough immobilization of both stock and scion, it also permits of examination of the vascularization without any unnecessary jeopardy to the graft. There need on the one hand be no guess work nor on the other any rigid adherence to a categorical time schedule. If, by constricting the base of the pedicle, the blood supply to the graft be found insufficient, the interval between the two operations may be so increased as to preclude the possibility of premature severance of the pedicle. Moreover, by reason of the excellent circulation which is maintained through the pedicle, it is possible to use a graft sufficiently thick to afford a good pad for walking even if allowance for tissue absorption is made. Because of the fact that, at the outset, it is not sutured around all its sides, the possibility of fluid collection beneath the flap is minimized and another factor in the take of the graft assured. Because of the fact that it is sutured only around at most two-thirds of its circumference, the baneful affects of concentric shrinkage of the graft is avoided, and primary union at the suture line made more certain. In a word the use of a pedicle graft reduces the element of chance in the ultimate outcome, and places the surgeon completely in control of the progress of the reconstruction.

#### REFERENCES

1. WILE, E. J. *J. Cutan. Dis.*, 30: 192, 1912.
2. HUTCHINSON, J. *Brit. M. J.*, 11: 230, 1887.
3. PARIS, J. A. *Pharmacologica*, 2: 70, 1825.
4. OSBORNE, E. D. *Arch. Dermat. & Syph.*, 12: 773, 1925; 18: 37, 1928.
5. SUTTON, J. B. *Brit. M. J.*, 2: 788, 1916.
6. BRODERS, A. C. *Ann. Surg.* 73: 141, 1921.



# UTERINE TRANSPOSITION OF THE OVARY

## WITH CONSERVATION OF ITS VASCULAR-NERVOUS PEDICLE\*

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FOR a long time, surgeons, struck with the occasional serious troubles and accidents which follow the castration of a woman who is still young, have come back to conservative surgery of the feminine sexual glands.

These accidents arise from the suppression of the ovaries which abolishes, at one time, the function of ovulation and the secretion of the ovarian hormone. It is thus wrong to describe them under the name of an artificial or premature climacteric; the climacteric does not directly destroy the internal secretion. Therefore the procedure is rather a castration.

The limits of this article do not permit us to give a complete history of the conservative evolution of ovarian surgery; we wish only to state that it includes three phases:

1. Experimental study
2. Grafting or ovarian transplantation
3. Uterine transplantation of the ovary provided with its vascular-nervous pedicle.

### EXPERIMENTATION AND GRAFTING OR TRANSPLANTATION OF THE OVARY

Almost simultaneously there appeared experimental studies on rabbits and guinea pigs and clinical studies concerning grafting or transplantation of whole ovaries or fragments of ovaries. In both categories of cases autografting, and sometimes homografting were employed with better results for the first than for the second.

These graftings or ovarian transplantations can assure, at least for a time, the internal secretion of the ovarian hormone with beneficial effects. The recent studies of Voronoff serve as a proof. But there is no hope for ovulation and fecundation.

### UTERINE TRANSPOSITION OF THE OVARY PROVIDED WITH ITS VASCULAR-NERVOUS PEDICLE

In the year 1908, with a view of conserving the menses and the possibility of pregnancy in a woman thirty-two years of age suffering from a double salpingitis with suppurated cyst of the right ovary, we attempted to transpose the left ovary into the uterus, conserving at the gland its vascular-nervous pedicle.

To our mind, this procedure, leaving to the ovary its normal vascularization and innervation, should have assured, better than any other, the aim we had proposed ourselves, inasmuch as the conditions of vitality of the gland had not been changed. There was no question of a graft or transplantation, more or less hazardous, but only of a transposition of the ovary without any change in the physiological conditions of its nutrition.

This first trial was crowned with full success; the catamenia was not troubled and a normal pregnancy followed resulting in an easy confinement at term, of a well-conditioned child.

We presented this observation and another of the same kind at the Société de Chirurgie October 18, 1922, and Professor Tuffier honored us by drawing up a report on our work. No other operation of the same kind had been published hitherto. Interested in our new conservative operation, Professor Tuffier used it with success in this same year, 1922, on one of his patients. In 1924, he published, with Professor Letulle, 29 personal cases of this same operation.<sup>1</sup>

<sup>1</sup> *Presse méd.*, 32: 465, 1924.

\* Submitted for publication August 17, 1931.

On the other hand, Mr. W. L. Estes<sup>1</sup> of Bethlehem (Pennsylvania), published a study in which he indicates his technique and his results for an operation similar to the one we had described. Doubtless, without knowledge of our work, he had had the same idea.

Since that time, we have had occasion to repeat this same operation several times; it has been followed sometimes with success as regards the persistence of normal menstrual periods, sometimes also as regards pregnancy, but, naturally, not in the majority of cases.

#### AIM OF THE TRANSPLANTATION OF THE OVARY WITH CONSERVATION OF ITS VASCULAR-NERVOUS PEDICLE

This operation proposes to conserve both the secretion of the ovarian hormone and the function of ovulation, with the possibility of pregnancy and confinement at term.

For this purpose, it is important that the ovulum enter the uterus and that the ovary conserve to the utmost, all the elements which control its nutrition, i.e., its vascularization and its innervation. For this reason we thought to introduce it into the uterine cavity, thereby conserving its vascular-nervous pedicle.

Let us examine the constitution and the seat of this nutritive pedicle whose integrity we are trying to conserve.

*A. Arteries of the Ovary:* The arteries which irrigate the ovary, ten to fifteen in number, meet this organ principally on the inferior part, its hilum.

Two arteries are the source: the uterine, on the inside, and the internal spermatic on the outside. The uterine and the internal spermatic each send a branch towards the other: the utero-ovarian coming from the uterine, and the ovarian coming from the internal spermatic. These two branches anastomose in a duct, below the hilum. They are of unequal importance; the utero-ovarian decidedly surpasses the other in caliber.

<sup>1</sup> *Ann. Surg.*, 82: 475, 1925.

The utero-ovarian sends towards the hilum six to eight vertical branches (short ovarian arteries), which furnish the blood to the main part of the genital gland. Of the two annexed branches of the internal spermatic, one, the tubo-ovarian artery, sends two or three branches to the tubal pole of the ovary; the other, the ovarian branch, sends four or five branches to the superior part of the ovary (long ovarian arteries).

All these arteries are helicine, and consequently susceptible of lengthening; they are, with respect to their structure, rich in contractile elements. As a result of this arterial disposition, the nutrition of the ovary is principally commanded by the utero-ovarian branch of the uterine; and that the greater part of the branches penetrate by way of the hilum of the organ.

It is thus the hilum, and particularly its internal part, which must be respected, in order to conserve good nutrition; however, this is not absolute, since anastomoses are numerous.

*B. Veins of the Ovary:* Originating from the capillary network, the veins converge towards the center of the ovary, increasing very rapidly in volume; they are even more flexuous and more helicine than the arteries, and form a plexus in front of and behind the arteries. They happen to form, on a level with the hilum and below it, a plexus which may equal the volume of the ovary itself (Rouget).

They are accompanied by numerous non-striated muscle fibers and form with them what has been described under the name of the spongy body of the ovary. Thence start the afferent veins, which empty into the internal spermatic veins, and, especially, into the uterine veins.

As a result of their disposition, the hilum, and above all, its internal part, contains the principal paths of the returning circulation.

*c. Lymphatic Vessels of the Ovary:* Originating around the follicles, in the shape of capillary spaces, they form a tightened

plexus on the limits of the cortical and medullary zones (Rieffel).

They form, on the hilum, a network below the venous plexus, whence start vessels that link themselves together in order to form only four to six trunks, which follow the internal spermatic vessels below the peritoneum, pass in front of the primitive iliac vessels, cross the urethra and fall into the lumbar-aortal ganglia. Sometimes, an isolated lymphatic passes below and outside, in the superior part of the broad ligament and falls into a ganglion of the middle chain of the internal iliac group (Marcille).

Like the sanguineous vessels, all the lymphatics reach the hilum of the organ.

*D. Nerves of the Ovary:* The nerves of the ovaries, but little known for a long time, though they had been described in 1680 by Willis, and in 1783 by Walter, were studied in a more precise manner by Hovelacque in 1925, by Robert Segond in his thesis of 1926, and then by J. Lhermite and Robert Dupont, in a communication to the Académie de Médecine, May 4, 1926, and in an article published in *Gynecologie et Obstetrique*, March 3, 1925.

Without stopping to consider the terminal distribution of the nerves of the ovaries, which is not of direct interest in the surgical question that we are studying here, we will only recall that the nerves of the ovary proceed, according to Hovelacque, from the renal plexus of the sympathetic, which is directly connected with the celiac plexus.

The nerves of the ovary descend, following the course of the utero-ovarian artery and receive, on the way, two or three branches of the intermesenteric plexus. In numbers of two or three, they reach the ovary in the middle of its hilum and penetrate into the organ. They follow the artery at a distance without actually joining it.

Lhermite and Dupont state that the external region of the hilum is very poor in nerve fibrils; the internal region is almost unprovided for. It is only at the

middle part that they are found, and always at a distance from the vessels.

It follows, as for the vessels, that the external part of the ovary can be mobilized or partially amputated as far as the nerves are concerned. We are still very ignorant of the exact rôle of the nervous sympathetic fibers of the ovary.

Lhermite and Robert Dupont have sectioned the hilum in order to overcome the pains of sclerocystic ovaritis; they were successful in realizing what they call "the enervation of the ovary." They infer from their operations "that the enervation is absolutely an anodyne and has no pathogenic action on ovulation and the function of reproduction."

Be that as it may, it seems to us more logical to respect the nerves of the ovary in a transposition of the organ. The conservation of its innervation can only be favorable for the trophicity of the organ, which has been transposed into the uterine cavity.

#### OPERATIVE TECHNIQUE

The belly being opened, with the patient in the Trendelenburg position, the intestinal mass is covered by protective compresses and the pelvic cavity exposed.

It must be ascertained whether the uterus is in good condition and can be conserved. The diseased annexa are completely disengaged from their adhesions. We suppose that their examination has led to the ablation of the Fallopian tubes and one ovary.

*Examination and Treatment of the Remaining Ovary:* The ovary which has to be transposed must be examined with care; if it presents an isolated cyst, a cuneiform resection is made, followed by a suture with fine catgut, thus reconstructing the ovary.

If it presents microcysts, one must split it, following its great axis on the convex extremity, and excise all the cysts with curved Mayo scissors. The two parts are stitched together and maintained by a cappadine stitch; a continuous

suture, with fine catgut, unites the extremities of the ovarian incision.

The question is now to transpose the

the mobilization of the ovary towards the uterine horn becomes easy and its nutrition is not compromised.

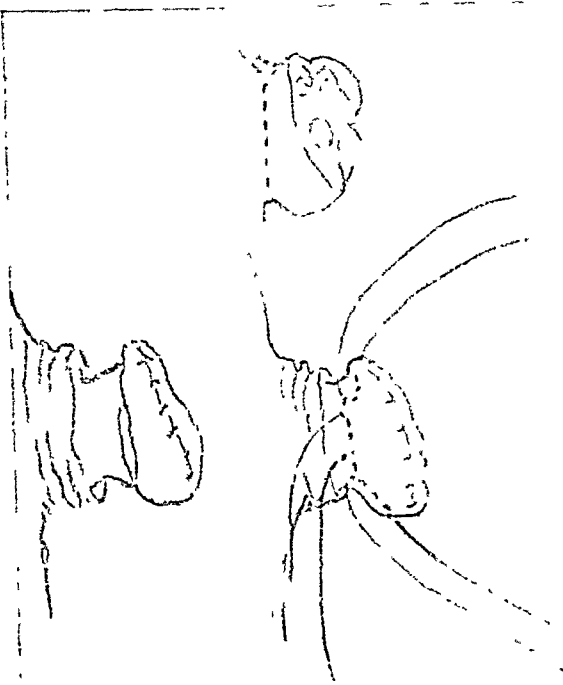


FIG. 1.

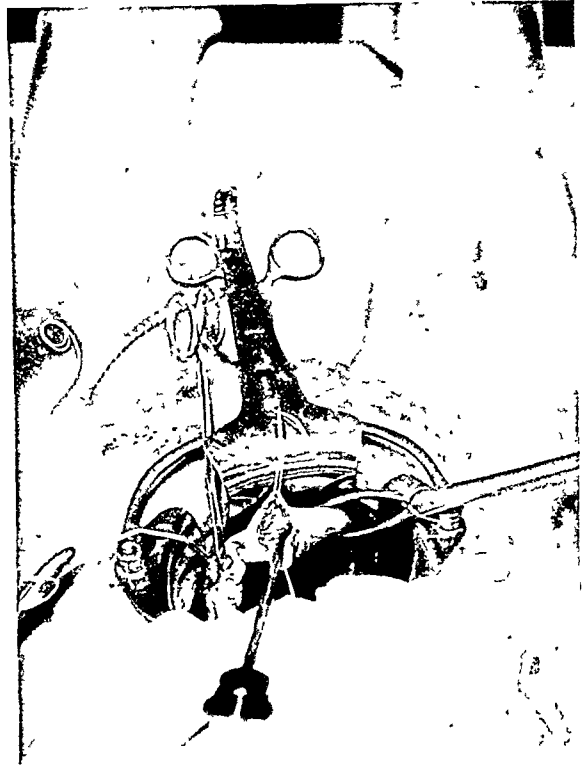


FIG. 2.

ovary into the uterine cavity. This operation includes several steps:

1. *Mobilization of the Ovary:* The first aim is to mobilize the ovary sufficiently in order to bring it, without pulling, around the corresponding uterine horn. It must be freed of all pathologic adhesions. The tubo-ovarian ligament will have been cut in raising the tube.

It is then necessary, in order to mobilize the ovary well, to incise with precaution the peritoneum, all around the pedicle, several millimeters from the gland (Fig. 1).

One then detaches the peritoneum from the pedicle, following the plane of cleavage of the subperitoneal cellular tissue. As soon as the detachment is begun, it is easily completed by the gauze-covered index finger.

The ovarian pedicle is thus without peritoneum, for a height of at least 1 cm. The gland is now very movable; the vessels of the pedicle being helicine and moving forward in loose cellular tissue,

II. *Setting of Suture Material on the Ovary:* We believe it useful at this time, to place the sutures on the ovary. In this manner, when the third operative step, i.e., the opening of the uterus, is performed, the sutures can be passed without delay into the uterine wall; thus the loss of blood will be reduced. Moreover, these sutures serve to remove the ovary, without manipulation, during the opening of the uterus.

Four loops, in U shape, of fine chromic catgut (00) are placed on the four poles of the ovary, at its base, near the insertion of the pedicle. The loops of the external and uterine poles form two U's, with united branches; the loops of the anterior and posterior faces form two U's with branches farther apart.

Each loop, which must be kept long, is grasped by a forceps, without the two ends being knotted.

III. *Openings of the Uterus:* We open the uterine cavity by a frontal, angular incision, passing by the uterine implantation

placed on the ovary, are then passed into the uterine wall, from inside to outside.

The needle penetrates the peritoneum

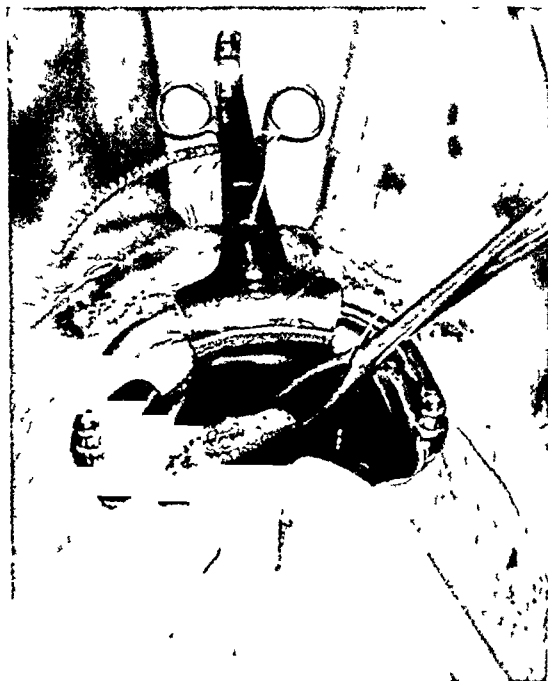


FIG. 3.

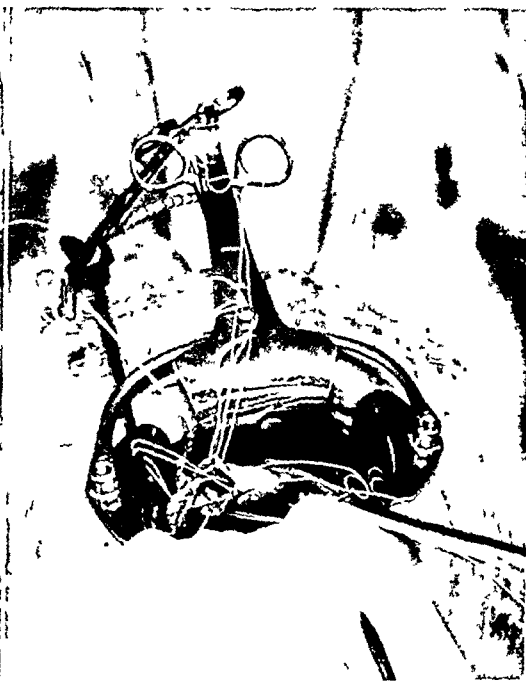


FIG. 4.

of the tube. We do this with the diathermic point of the bistoury. This incision is prolonged for 2 cm. on the corresponding part of the fundus and for an equal length on the superior part of the border of the uterus. This frontal incision forms an angle of which the tubal mouth marks the apex. It must be a clean and frank one, penetrating at the first onset into the uterine cavity. The bleeding is trifling (Fig. 2).

It is necessary to make certain with a grooved probe that the uterine cavity is widely opened and to be able to locate its mucosa (Fig. 3).

Tuffier proposed to dilate the cavity with Hégard bougies, in order to prepare the bed of the ovary. We never needed to have recourse to this artifice, which seems useless to us, if the operation is performed on the uterine horn and not on the posterior median line of the organ.

IV. *Passage of the Sutures into the Uterine Edges:* The four loops of catgut in u shape,

and the uterine muscle as well, half a centimeter from the lips of the incision, and going forward obliquely, it keeps close to the mucosa, in order to receive one end of the loop in u shape. Thus the needle will pass eight times, in order to pass the eight ends of the four loops in the u shape.

The ends of the loops in u shape of the internal uterine pole of the ovary will be the first to pass at the inferior angle of the uterine incision, on the edge of the uterus. The ends of the anterior and posterior points in u shape of the ovary are passed at their turn into the corresponding lips of the uterine incision. Finally, the ends of the external pole of the ovary are passed into the angle of the fundus of the ovarian incision (Fig. 4).

V. *Introduction of the Ovary into the Uterus:* By gentle drawing on the two ends of each of the four loops, the ovary is turned on a pivot, and its convex border enters into the uterus. It is generally

necessary to push it to the bottom with the help of a blunt instrument in order to assure its penetration (Fig. 5).

have been able, in a good number of cases, to transpose a whole ovary intact.

It is necessary to push the ovary well

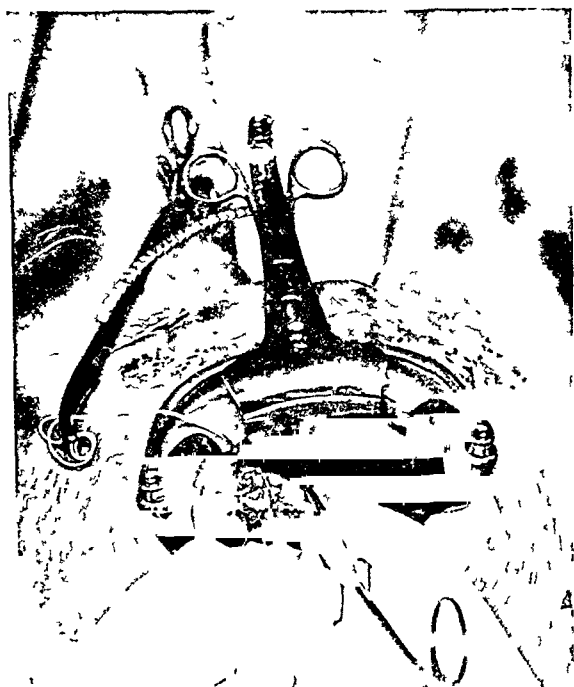


FIG. 5.

vi. *Closing of the Uterus:* One or two points of suture on either side of the ovarian pedicle will close the uterine wound and will be sufficient to assure hemostasis of the edges.

It is necessary to take care not to transfix the pedicle of the ovary, in order to respect the vessels and nerves.

vii. *Peritonealization:* The collar of the peritoneum detached from the ovarian pedicle comes into contact with the uterine peritoneum, with which it unites rapidly. If the peritonealization does not appear sufficient, it will be easy to cover the operated horn, drawing and fixing the round ligament on it, as we have sometimes done.

#### REMARKS

If the ovary has been reduced by a cuneiform resection, its penetration into the uterus is much easier. However, we



FIG. 6.

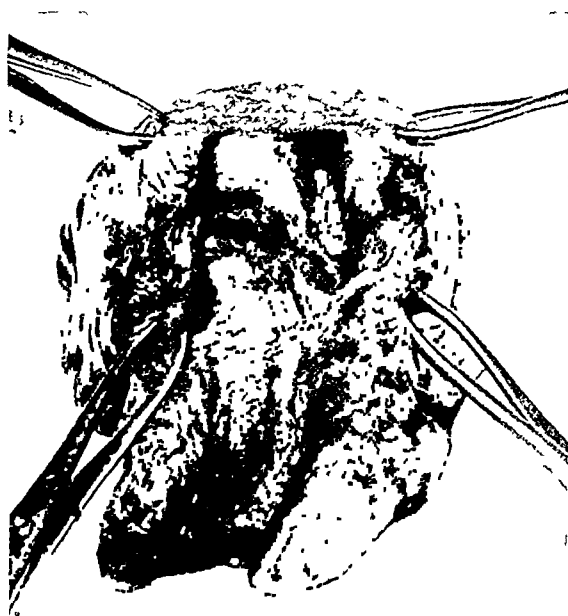


FIG. 7.

to the bottom into its new position, in order to prevent its tendency to come up again. It cannot be pushed too far, because

its new position is commanded by the four points in U shape.

With some patients, we have been able to manage the transposition of the two ovaries, without special difficulties.

Such is the operative procedure we have established.

Our regretted master and friend, Professor Tuffier, who was interested in this question, after having been our reporter at the Société de Chirurgie and after having seen us perform this procedure various times, afterwards modified our technique, placing the uterine incision vertically in the posterior median line, in a sagittal plane (Fig. 6). Doubtless, he chose the median line in consideration of its lower vascularization. We did not follow him in this respect but remained true to our original incision on the uterine horn, which seems to us preferable for the following reasons:

(a) It is easier to bring the ovary into contact with the horn, then into contact

with the median line, because the distance is somewhat less.

(b) The seesaw of the ovary is made around its uterine poles, as a hinge; thus, there is no pulling on the uterine blood vessel and its ovarian branches, and the circulation is not disturbed, especially not the venous circulation. Indeed, it must not be forgotten that the venous walls are much weaker than the arterial walls.

(c) The uterine horn seems to us a more physiological seat for the transposed ovary than the posterior face of the uterine body. It is sheltered there in an angle of the cavity, instead of being exposed in the very middle of this same cavity (Fig. 7).

(d) On the uterine horn, the transposed ovary suffers less risk of becoming a foreign body and does not incite the uterine muscle to contract, in order to expel it, like a polyp. M. Tuffier observed this accident, which we never had, when placing the ovary into the uterine horn.



#### REFERENCES OF DRS. KRETSCHMER AND HECKEL\*

- |  |  |
|--|--|
| MEYER. Klinik der Nervösen Störungen der Blase. <i>Hand. d. Urol.</i> , 13: 415-428, 1928.                                   | TATTERSALL. A case of idiopathic dilatation of the bladder and ureters. <i>Lancet</i> , 1: 534, 1921.                        |
| MOLLIÈRE. De La Dysurie Senile. <i>Lyon med.</i> , 63: 369, 1890.  | ULTZMANN. Die Krankheiten der Harnblase. <i>Deutsche Chir. Lief</i> 52, 348, 1890.   |
| MOORE. Diagnosis of bladder atony. <i>J. Tennessee M. A.</i> , 19: 286-292, 1927.  | VASSALO. A case of idiopathic atony of the bladder. <i>Lancet</i> , 2: 599, 1920.  |
| PAGET. Stammering bladder. <i>Brit. M. J.</i> , 2: 437, 1868.  | WALKER. Atony of the Bladder without obstruction or signs of organic nervous disease. <i>Ann. Surg.</i> , 52: 577-596, 1910. |
| SHATTOCK. Is there an idiopathic dilatation of the bladder? <i>Proc. Roy. Soc. Med.</i> , 2: (Path. Sec.) 88-100, 1908-1909. | WARE. Non-prostatic urinary retention of the senile bladder. <i>Ann. Surg.</i> , 53: 57-66, 1911.                            |
| SMITH, G. Bladder disturbances due to nerve lesions. <i>J. A. M. A.</i> , 69: 1323-1327, 1917.                               | WILSON. Two cases of idiopathic muscular paresis of the bladder. <i>St. Barth. Hosp. Rep.</i> , 48: 81-85, 1912.             |
| STUTZIN: Harnretentionen ohne Nachweisbare Ursachen. <i>Deutsche med. Wchnschr.</i> , 48: 356, 1922.                         |  |

\* Continued from p. 88.

# HYDROGYMNASTIC EXERCISES FOR ACUTE INJURY

A PERSONAL EXPERIENCE\*

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HAVING written and theorized for a number of years about the use of underwater gymnastic exercises as applied to a variety of cases, I had occasion recently to give them a personal test in the Hydrogymnasium of the Orthopaedic Hospital in Los Angeles.

On December 22, 1930, in an automobile accident, I suffered the following injuries: fractures of the lateral processes of four lumbar vertebrae, avulsion of muscles and ligaments from the posterior aspect of the left ilium, fracture of the tip of the coccyx, subluxation of the left knee with rupture of the posterior crucial ligament, acute traumatic synovitis of the right knee, a crushing blow diagonally across the right thigh, tearing the quadriceps and vastus lateralis with the production of a very large and extensive hematoma, severe twist of the pelvis and hip joints and abrasions and contusions too numerous to mention.

After eight days in a plaster spica, I was transferred into a snugly fitted body brace and leg splints and from then on began physiotherapeutic treatments, chiefly cotton compress for the right thigh, baking and massage, alternating with pool treatments. The following diary shows the result of them. To begin with, active voluntary movements of the legs could not be made without acute pain, but in the water could be painlessly made as indicated, through quite a considerable arc.

12-30-30: Afternoon, cautious light back rub.

12-31-30: Pool. Left knee 60° at first, end of treatment to 80°. Right knee 30°, end of treatment 45°. Compression massage of thigh during flexion movement of knee, and forcible extension in water. Ankle nearly complete. Hip joint 75° before ten-

sion on adductors, with pain. No pain caused in back for this degree of leg movement, body weight almost wholly supported on plinth at adjustment of first inclination about 70°.

1- 1-31: No pool. Hot fomentations to right leg and thigh, followed by massage. Knee motion passive action 40°.

1- 2-31: Left knee increased to 90°. Right to 50° before spasm from tension of quadriceps at point of crush.

1- 3-31: Pool. Left knee to 85°. Right to 60° at end of treatment. Compression massage during treatment. Note: Upper lymph channels emptied first, then worked down to knee. Hip range nearly normal. Ankle practically so.

1- 4-31: No pool. Cautious massage, stripping both legs. Especial attention to right knee and thigh. Straight leg limited to 60° before tension on back and sacroiliac.

1- 5-31: Knee movement improving. Right flex to 85°; left to 100°. First attempt to stand in deep water.

1- 6-31: Pool. Right knee to 90°. Left to 105°. Note: definite clicking crepitus in right knee, painful after a few moments. Walked across pool with crutches. Feeling of falling backward unless strong effort to lean forward. Very little pressure of arms would lift feet off bottom.

1- 7-31: Pool. Shallow, hot pool. Compression massage to right thigh during flexion and extension aids greatly in releasing movement. Tried resistance to abduction and flexion. When brought to maximum flexion, marked deep pain through lower femur. Resistance at this point relieved pain due to further relaxation of quadriceps spasm. Same in adduction. Action demonstrating Sherrington's law of

\* Submitted for publication June 10, 1931.



reciprocal innervation of opponent muscles.

1-8-31: Flexion left knee at start 90°; finish 110°.

Flexion right knee at start 85°; finish 100°.

Walked across pool without crutches. Caused pain over fracture area in back, left third and fourth lumbar, which remained all afternoon. Back splint not tight enough and too short a grasp of pelvis. Tendency to fall backward less.

1-10-31: Prone lying on plinth to get flat back and thigh flexion without gravity load. Got 90° hip and 120° knee without back pain. Only soreness and tension over hips. Knees at start, left 110°, right 90°. Walked across and back and did several squats at rail. No crutches. Could not rise without hand assistance on account of pain in knee joints, pinching fringes. Right knee still clicks under knee cap with slight pain.

1-11-31: Leg massage. No pool. Pain lessening about hips and knees. Still very sore to pressure over periosteum of right thigh, followed by aching.

From this point on, progress was steadily increased until walking in shallow water about up to middle. There was no pain but a sense of great weight in low back and around the pelvis. About January 20, the first attempt at standing in the room and taking a few steps showed a greater difference than one would expect between walking out of water and walking at shallow depth. Evidently, the aid of the water in lifting the legs as weight is removed from them is considerable, as the effort out of water, even with crutch support, was very great and quite fatiguing even after five minutes. In about another month to six weeks, I was able to begin movements of the back and pool treatments alternating with general and back massage. Considerable time, however, has been necessary to get to the point of full back movement without developing deep muscle soreness and some stiffness.

Most remarkable is the fact that for the first two weeks any effort at active motion of legs in bed produced pain in knees, thighs or back.

It was impossible to raise them from bed, without assistance. At the very first treatment in the pool, when it required great care in handling on table or guernsey, and even then there was great discomfort, it was most gratifying and comforting to get into the water and be able to move all joints to a considerable range before producing any pain.

One appreciates how rapidly muscle weakness from atrophy, inactivity and muscle guardings occurs, and how quickly the sense of control, as well as of power, is reduced or lost. Normally, we are not conscious of muscles or joints; only of movement, force, range, pressure, etc. but when every movement in bed provokes pain in joints and muscles, one is made aware very quickly of their existence. Movement requiring weight-bearing or against gravity may be impossible without pain. In the water, there is no load and one gets muscle action only, showing that very slight amounts of muscle action are possible even in bruised and painful muscles, provided the joint can move with only the slightest effort, which it can in the water. As soon as the muscles must combine in action to fixate any given segment, the pull becomes too great and pain ensues.

It is the preservation and use of this small amount of muscle power and joint motion that improves nutritive processes, hastens elimination of the inflammatory products and maintains the patterns of movement, thus hastening the return toward normal function.

Active efforts in the water are positive in control and the sensation of very slight gentle pressure of the water makes a continuous and positive point of contact throughout all planes equally at all points of motion, whereas when an assistant carries the weight of the painful part, even though he may be extremely gentle and expert in handling and one has implicit faith in him, his movements as passive assistant must be constantly felt, judged and allowed for by the patient in order to gauge his own active efforts.

In the water, one abandons himself to the gentlest support and gives his entire attention to controlling only his own action.

When it came to the point of working in an upright position and carrying some weight on the legs, the first time I experienced considerable uncertainty and could scarcely extend the knee without pain. Use of crutches in water breast high made me appreciate how very little weight was carried on the legs because only slight pressure on the hands raised the feet off the bottom. One literally goes through the motions of walking, only feeling the floor, and getting the consciousness of the act and making the proper walking motions. The element of balance disturbance was partly corrected by keeping the eyes fixed on the wall and not looking into the water. The slight wave and motion in the water

added an element of uncertainty to the eye channels of sensation; hence increasing the difficulty. Looking at the fixed wall with its fixed lines gave a position point for the eye to fix on; hence the easier readjustment and correction of body position.

The weakness and uncertainty of the first steps seem to feel about as the efforts of an ataxic look. I greatly appreciated the hoist which conveyed me from the dressing room to the pool, especially in comparing the ease and freedom from guarding and pain in getting into the water and getting from bed to wheel chair or guerney.

Experience is a sound teacher and this proof of the effectiveness of water exercises for acute injury justifies our use of it in the acute poliomyelitis cases and makes us realize the immediate value of it for the sick muscles and as a heightener of morale.



# EMBRYOGENESIS OF ANENCEPHALIA AND SPINA BIFIDA\*

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NEW YORK CITY

IT can be said that the origin of the study of teratologic alterations began with Aldrovandi,<sup>1</sup> who described with four diagrams two fetuses without the vault of the skull and without brain. Among the subsequent investigators who undertook the study of the subject, are found the names of Bartholino, Meckel,<sup>2</sup> Hoffmann,<sup>3</sup> Kerkring,<sup>4</sup> but they left no comprehensive classifications. It remained for Sandifort<sup>5</sup> to give the first conception of this deformity, and he was followed in 1805, by Malacarne<sup>6</sup> with the fortunate terminology of "acranic, aencephalic, an-auchenus," which terminology was adopted later by other authors.

Isidore Geoffroy Saint-Hilaire<sup>7</sup> named three types of the deformity:

- (1) Exencephalic.  
Fetus with brain malformed and out of the skull.
- (2) Pseudo-encephalic.  
Fetus with brain substituted by vascular tumor.
- (3) Anencephalic.  
Fetus without brain.

In reality these lesions are not found separately, which led Forster<sup>8</sup> and also Bauer<sup>9</sup> to offer a simpler and more practical classification. The classification that is adopted today is that of Taruffi,<sup>10</sup> who described the deformity by the degree of the lesion into two groups:

- (1) *Oloacranic*, in which there is a total absence of the vault of the skull extended down to the vertebral column.
- (2) *Meroacranic*, in which the lesion is limited to one part of the skull.

The principal characteristics have been known from early times when the head of the acranic resembling that of the cat and toad suggested a bestial intercourse

under divine power. At the end of the year 1500 Aldrovandi showed his first pictures, the scientific description of which came later. Schlegel<sup>11</sup> in the year 1812 knowing that these monsters have the jaw protruded as a monkey, was not able to give a clear description of them. About the middle of 1800, more detailed definition of the external form and internal deformities appeared. The authors noted a shortening of the normal diameter of the head, with large and protruding tongue. We learn from this description that they have a marked prognathism by abnormal growth of the facial bones, followed by other abnormalities such as the exaggerated growth of the tongue, which was noted by Melli<sup>12</sup> in 1732.

(1) The nose is flat, with its tip touching the superior lip, and the dorsal margin is in a straight line with the forehead.

(2) The eyes are large and protruding and, due to the obliquity of the forehead, are displaced upward. The appearance of the fetus is so strange that some author called them with the fancy name of "uranoscopic."

The bones undergo alterations in shape and position. The occipital bone when present becomes perpendicular and gives the appearance of the neck being set abnormally low between the shoulders and the face directed upward. The bones of the base of the skull, although shorter, undergo a larger evolution and form an osseous bulk that yields an upward convexity of the base. Many authors tried to find a theory to explain these altered positions. Bauer believes that the hydrocephalus produces, not only the anencephalia, but also a spasm in the muscles of the neck. This contraction therefore causes the opening of the bones

\* This work was done at the laboratory of Prof. V. Putti at the Institute Ortopedico Rizzoli, Bologna, Italy, and completed at the Columbus Hospital, New York City. Submitted for publication November 16, 1931.

with fulcrum under the atlas, secondly, the absence of the neck and the union of the chin with the breast. Limiting the study

in this way prolongs the encephalic lesion toward the spinal cord.

From this brief bibliographic examina-



FIG. 1. Ventral side.

to the oloacranics we learn that this is the most frequent alteration of the vault of the skull and is often followed by several organic defects.

Von Döversen<sup>13</sup> in these fetuses described the harelip. Gaddi<sup>14</sup> showed the cyclocephalus; the more constant alteration however, is the absence, or aplasia, of the suprarenal body. This lesion had been noted by Cotunnio in 1773, but was denied by Sömmering and confirmed again by other authors, who gave to it a casual influence. We know from J. Geoffroy Saint-Hilaire that in oloacranics rests of the brain or more often a spongy tumor rich in vessels and blood (pseudo-encephaly) lies on the open shell of the skull. Sometimes the bones of the base are covered only by thickened dura mater (anencephalic). We notice also that the first cervical vertebrae always show an opening of the arches, which in some cases is very wide and involves the front of the bodies of the vertebrae. The spina bifida



FIG. 2. Dorsal side.

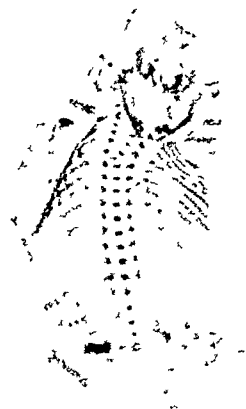


FIG. 3. X-ray of fetus. Vertebrae show platyspondylia where lesion begins.

tion it is evident that no histological researches were done on the tissues in the cephalic clefts at that time. Among the

several authors who studied the matter is von Recklinghausen,<sup>15</sup> who gave to us a clear and perfect picture of this deformity,

from this excessive growth of some parts and the arrest of others, we may think that some areas grow toward a complete



FIG. 4. Superficial section of harelip. Zeiss ob. 16 m. 6c.



FIG. 5. Internal closure of cleft of superior lip. Zeiss ob. 16m. 6c.

and until now his description has not been changed by the newer researches.

Recent studies show a close relation between spina bifida and the oloacranic (pseudo-encephalic) and Muscatello,<sup>16</sup> speaking of the medullo-vascular area of Recklinghausen said: "The analogy of both processes gives me the idea of calling the neurovascular tissue of encephalocystocele by the name of cerebro-vascular area."

As we know in oloacranics the brain is replaced by a spongy tumor rich in vessels and areolae within which are found islands of neurones. The lower strata of the differentiation yield only neuroglia or glia composed of oval and round cells, the preponderance of neuroglia being like that in the tissue found in teratoma.

As to the genesis of this tissue, it is believed that the epithelial layer of the midollar groove loses the power of heterologous differentiation (Zingerle<sup>17</sup>), being able to produce connective tissue only because of the lesion, or that the former tissue, being stronger, outlives the diseased.

With the differentiated ganglion cells are found embryonal indifferent cells;

development while others remain in an embryonal condition.

To explain the causes of so extensive a structural deformity many theories have been advanced. (Veraguth<sup>18</sup>) In 1750, Haller<sup>19</sup> placed external trauma among the occasional causes, although the teratogenesis has been more discussed than the etiology. The theory of hydrocephalus is due to Morgagni and was later advanced again by Rokitansky, but their opinion was not confirmed. The researches of Dareste<sup>20</sup> and Lebedeff<sup>21</sup> on the contrary, brought the genesis into the field of arrested developments. The amniotic adhesions were the cause of new discussions and to some author each deformity concerned inflammatory processes (Duchateau<sup>22</sup>). Only Recklinghausen finally gave a clear demonstration of his hypothesis in which he describes and defines the anencephaly as an arrested closure of the primitive neural groove. This last research of v. Recklinghausen has been confirmed by Faldino.<sup>23</sup>

As we see from the foregoing theories, the genesis of the oloacranic concealed

by the obscure embryonal development is unsatisfactorily explained up to the present time. The lack of understanding on our part is not due to failure of effort but to failure fuller to comprehend the importance of the biological dynamics.

Sectioning a stillborn fetus that showed anencephalia and a cervical spina bifida I had the opportunity of finding some structural peculiarities that I think well worth referring to as I believe the deductions drawn from them are useful in more clearly interpreting the genesis of this anomaly. It was impossible to gather any information concerning either the history or the objective symptoms of the mother or her pregnancy. After fixation the fetus was 4.8 cm. long from the vertex to the podalic extremity.

**VENTRAL SIDE (Fig. 1):** The head has lost its normal characteristics, being flat and on the same plane as the body, and it assumes the shape of an inverted trapezoid with its base downward almost as if it were a prominent tumor protruding from between the shoulders. There is no neck excepting a fold of skin that barely divides the head from the rest of the body. From the flattened cephalic vertex there arise folds of skin which are very difficult to diagnose and which I put aside to examine in sections.

The forehead, low and almost absent, has two small lumps representing the eyes and cut in the center by the palpebral rim; farther down, in the middle of the face, there is an oval swelling formed by the nose, the mouth and the chin. The nose, badly outlined, is demarked by a slight fissure that divides it from the upper lip; this fissure joins at its right end another which is perpendicular and which farther down run into the oral cavity, dividing the upper lip in two parts, the left being larger and going beyond the medial line, the right being smaller and less pronounced. The mouth opens by an oval and semicircular fissure, the cavity containing a protruding mass of flesh representing the tongue. The thorax and the abdomen seem to be fused into a single rectangular mass flattened and furrowed, especially below, by some cutaneous folds without any real morphologic meaning. With the exception of the head the fetus has the

proper proportions and an almost normal development.

**DORSAL SIDE (Fig. 2):** At the cephalic



FIG. 6. Cerebrovascular area. Zeiss ob. 16 m. 6 c.

vertex appear the folds, already mentioned, which are divided into two parts. The entire posterior wall of the head is deformed and seems lacking in bone parts, being covered only by thin veil-like tissue that shows underlying trabeculations. In this posterior region also the head meets with the back without any clear division. At the joining point of the spine and the head there is a poorly demarked cavity with the depth of about 1 mm. The entire body is almost level and has in its middle part a longitudinal swelling formed by the spine.

The internal microscopic examination shows that the fetus, of feminine sex, has noticeably hyperplastic suprarenal bodies, the other organs, including the spine between the seventh thoracic vertebra and the sacrum, being normal.

The radiographic examination, as seen in Figure 3, shows a jaw that was much more developed than normal. The points of ossification of the mastoid processes, of the zygomas and of the palate are very clear and, although they are slightly misplaced in relation to each other, do not seem to have extensive deformities. The superior part of the skull gives no shadow, leading one to think that there is no bone or cartilaginous structure. The nuclei of ossification of the vertebrae, well placed, give evidence of platyspondylia (Putti<sup>24</sup>), and of a spina

bifida which, beginning at the sixth thoracic vertebra, extends to the base of the skull where the nuclei of the lateral processes diverge

attached. Continuing farther it is found that the cartilaginous organs of the face follow the general malformation with slight modifications



FIG. 7. Frontal section of spine. 1, Costovertebral joint. 2, Nucleus of ossification in body of vertebra. 3, Embryonic rest of spinal cord. Koristka. I  $\times$  ob.



FIG. 8. Vertebral cleft. 1, Enlargement of vertebral canal. 2, Thickened meningeal membrane surrounded by vessels. Farther up, meninges become atrophic. 3, Mass of ganglions fused together. Koristka. I  $\times$  ob.

considerably. Considering the age of the fetus the other bones are normal in development and form.

**TECHNIQUE.** As a fixative formalin was used in precedence For the histological examination I removed the head and the upper part of the spine up to the seventh thoracic vertebra, then I treated these parts according to the method of Ruffini. The sections made in series were colored with hematoxylin and eosin.

**DESCRIPTION.** Immediately in the first sections appear the chin, the tongue, and the nose, showing no anomaly in their histological structure; the attention is attracted, however, by the opening of the upper lip; in its periphery glandular bodies are well developed. The two edges of the median cleft lack these bodies and present instead a condensation of cells, the nuclei of which are oval. Two slender cellular bridges are also noticeable, which unite the rims of the fissure. This evidence of harelip led me to believe that the cleft extends to the palate. Before penetrating the oral cavity it closes itself by means of a connective tissue suture, to which many muscular fibers are

in their relationship that would be too long and of no use to describe here.

There is a marked enlargement of the jaw and an almost absolute lack of frontal bones, but above all, one is struck by the abundance of cartilaginous formations and their anomalous position. In the successive sections the bodies of the thoracic vertebrae begin to appear. These are large and formed of thick cartilage to the periphery which gradually take on cells at its center where a nucleus of ossification is already beginning.

In various points of the cervical bodies there is a median connective cord which crosses oval cavities situated between one vertebra and another; this represents the embryonic rest of the spinal cord. The costovertebral joints are unaltered, although in some of them the two cartilages are united by thick connective tissue; in others spaces are forming which later will serve to form the synovial capsule.

Nerves that are normal in form and structure appear between each of the lateral processes unmodified and provided with a small nucleus of ossification. The spine forms in relation to

the first thoracic vertebra a slight lordosis that corrects itself above. The bones of the base are hyperplastic and, even though shorter, assume a

examination can be defined as the fusion of many spinal ganglions is found. The ganglions, which in the thoracic region are well formed



FIG. 9. Vertebral canal begins to open. 1, Muscles of neck. 2, Vertebral canal contains broken medulla and atrophied meninges. 3, Bones of base altered in shape. Koristka. I  $\times$  ob.



FIG. 10. Opening of vertebral canal. 1, Skin transition into cerebrovascular area (epithelio-serosa). 2, Opening. 3, Rest of vertebral lamina. 4, Rest of altered medulla. Koristka. I  $\times$  ob.

considerable size especially in the middle. The temporal bones have a large center of ossification at the mastoid and assume a wide open cup shape from front to rear. The sphenoid, not large but thick, makes the base of the skull convex. The superior bones are totally absent, the occiput only seems faintly outlined toward its lower part.

Proceeding with the section of the vertebral canal at the level of the sixth thoracic it is found that the canal below that level is normal while the canal above this level is abnormal which, as I will show later, makes a large opening at the posterior part of the head. The meningeal membrane beginning at the level of the lesion seems normal and continues upward without interruption, the subdural space being only a little enlarged. In its peripheral part there is a bundle of connective tissue and around the dura mater there is instead a large number of vessels.

At the point of opening exactly where the lordosis is most accentuated the meninges continue to form. However, a large subdural space of nervous tissue which under careful

and regularly placed in this connective space fuse themselves into a single mass of nervous substance. The vertebral canal with its opening takes up the entire lower occipital region and open completely further up to the right. The medulla that is normal below the level of the seventh cervical vertebra changes as it goes upward by enlarging and breaking in various points: then instead of continuing with the encephalon it comes out of the opening and thus modified it covers the base of the cranium.

The entire region of the head and the folds that cover it are not covered by the bones but are formed by a neurovascular mass that represents the encephalon. Examining the histological structure of this tissue with high power magnification it is found not to differ much from that of the cerebrovascular substance. There are a great number of areolae that are full of blood and develop without any precise order. They predominate at the periphery of this spongy mass while nearer the base of the cranium zones of nervous tissue of oval and large round cells are found that must be interpreted as undifferentiated glia.



At the level of the enlarged medulla when the afore-described lesion begins to form the ependymal tissue breaks up. Although it is lost

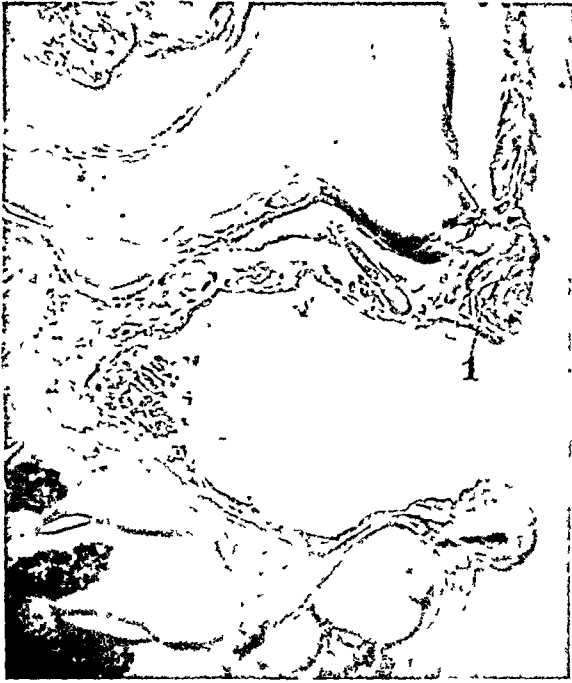


FIG. 11. Complete opening. 1, Rests of nervous tissue surrounded by cerebrovascular tissue. Koristka. I  $\times$  ob.

on the head because of its frailty, it is still recognizable in various places massed into small circumscribed areas.

The following section is characterized by great deformity of the vertebral arches. The vertebral canal instead of being closed shows posteriorly a very large opening that increases upward because of the progressive absence of the lamina and of the spinous processes. The fourth and fifth thoracic vertebra begin to have arches larger than the normal, those further up divide and they grow wider from below upward until it is found that the first cervical vertebra are formed only by the body and the lateral processes. The greater part of the missing lamina is replaced by the large aperture that communicates with the afore-described vertebral sac, whereas, at a small tract farther down they are completed in a rudimentary manner by thick connective tissue.

Many other structural particularities would be worth examining but I think this description is already too heavy for the reader, so that I prefer to limit my description to the principal lesions. I will add that all the muscular masses

of the neck and of the thorax are very well developed and well preserved in their relationships. The epidermic layer also is normal in all the uninjured surfaces, but gradually as one approaches the altered parts the skin becomes thinner and atrophic and loses its follicles and glandular outline. There is a gradual transition into an area made up of connective tissue of close fibers that are not, however, in continuation with the subcutaneous layer.

From this examination it can be seen that the description of many authors corresponds in part to the one I have verified; there are, however, small details that I will try to explain briefly, not using the classical theories but referring instead to the recent dynamic conceptions of embryological development.

In this fetus the lesion of the encephalon and of the medulla can correctly be understood as a lack of closure of the neural clefts caused by unknown agents that have acted in the primary phases of embryogenesis. The majority of authors give the same interpretation, especially as regards the spina bifida. In my case this opinion is clearly confirmed on the following points:

- (1) The gradual rise of the lesion upward.
- (2) The enlargement and the wide opening of the spina.
- (3) The settlement of the ependyma.

But I am not so interested in explaining the small details I have found as in bringing the genetic study of these lesions from the useless field of embryological mechanics into that of biological dynamics. As is already known the first outline of the nervous system is represented by the primitive line which in its final development is related to and connected with other structural parts, parts that modify it and help in its morphogenesis under the influx of active cellular forces and secretion. In the center of the neural area the ectodermic cells are active and assume the shape of a club which begins to grow deeply into the mesodermic stratum. The median part of the mesodermic stratum thickens and, by active multiplication, grows around the

cells forming the outline of the notochorda. Thus the primitive line is a consequence of the "stictotropic" movement directed toward the center of the germ, whereas the spinal cord, because of the union of the axial median part of the ectoderma, will later be useful as the fulcrum for the raising of the neural folds (Ruffini<sup>25</sup>).

Studying the successive phenomena it is found that the mesoderm is the seat of important modifications, in fact in this intermediate region it thickens as a club and further out forms the great pleuroperitoneal cavity. This sac, overfilled with liquid by the gradual increase of internal pressure, modifies the superficies of the body in such a manner that the neural folds rise and close like the pages of a book. The formation of the neural cavity is made by these various processes already described and not by the cells of the folds. These cells have no morphogenetic function but are merely the focus of cell multiplication. Important phenomena which determine the external form of the embryo develop as soon as the neural groove is changed into a tube. After the closure of the two folds the secretion of the ectodermic cell begins to collect and not being able to evacuate externally, creates a pressure that is a new cause for somatic modifications. The liquid thus secreted exercises a uniform pressure that will be felt differently according to the size and resistance of the walls that surround it. The curvature that the embryo assumes and the various developments of the vesicular cavities are directly dependent upon this in their size and placement. The raising of the amnio-chorial folds is produced by the same secretive and osmotic causes. All these phenomena that guide the development and the morphogenesis of the embryo seem the result of multiple stimuli and dynamic actions brought upon the cellular territories, from which the various organs will originate. The cells secrete substances which, aside from being the cause of osmotic actions, also bring stimulating hormones that are comparable to those of a

real internal secretion. The teratological lesions must be ascribed to the altered embryonal biochemistry, and not to the inflammatory processes as previously supposed; this hypothesis can be called truth after many authors have been able to produce lesions and delays in the primitive morphogenesis of the germ after indirectly modifying the chemical constitution of the embryo (Ferret-Weber).

According to many authors the anencephalia and the spina bifida would not be the consequence of a failure in closing of the neural groove but a tardy phenomenon that happened when the closing of it was already completed. This is a mistaken hypothesis but under certain aspects can be partly true. Ruffini explains a histologic discovery that is of great importance to us. He had the opportunity of studying an anencephalic chicken egg after seventy-two hours of natural incubation. The neuraxis of this embryo was completely open, except in two places where it had been successful in closing by a secondary manner. From the examination of the open neural folds it was seen that they were larger at the margins by a thickening of the ectoderma and that each one of them had in its median axis a mesenchymal layer provided by blood vessels. Thus it is seen how the folds incapable of joining together earlier have completed their closing with a restoring process depending on the vascular mesenchymatic neoformation and on the thickening of the ectoderm at the margins of the groove.

Supposing that this secondary restoration had in certain cases closed a primitive limited opening of the neuraxis, we can easily understand how many authors, encountering this vascular tissue of mesenchymal origin, have interpreted the anencephalia and the spina bifida as issues of late changes or of inflammatory processes.

The amniotic folds which join each other a little above and on the same line of the neuraxis in consequence to the alterations of development are subjected to the same reparative processes; therefore, in some

cases it is not remarkable that some adhesions that unite the head to the amnios are found. After these explanations I believe I can maintain that the cerebro-vascular and medulla-vascular tissue of Recklinghausen are the same as the vascularized mesenchyma of Ruffini. The examination of my fetus seems to confirm this idea. The medial part of the lesion formed by remains of nervous substance and ependymal cells is surrounded by this large vascular zone of spongy mass. This spongy mass is situated to the lateral side of the opening in the spinal canal but at a high level toward the encephalus it covers and even includes fragments of nervous mass. The belief that an inflammatory process localizes in the slender tissue of such a small fetus is highly imaginative and without foundation. The chemical and physical agents that were tried on the eggs have produced instead deformities similar to the anencephalia and spina bifida. The genesis of this anomaly therefore, is due to the changes of the embryonal biochemistry. The Recklinghausen's tissue cannot be homologated to any other but to that of Ruffini.

The failure of the closing of the neuraxis explains to us another deformity in fetuses with incomplete brain. We said that they have no neck, and the head is turned backward with the face turned up. This deformity of extension of the head is in reality not caused by contraction of the muscular masses but rather to deficiency of the internal pressure of the open neural canal which permits the head to fall backward on the trunk.

In the development of the trunk it will not assume a normal curve because the evolutive power of the neural tube is lacking or incomplete. Therefore, the action of the muscles can only have an influence on the extended position of the head at a later period and is not the primary cause of the deformity. The phenomena here described influence both the external forms and the internal structure of the bones which changes their relation and shape. The case referred by Ruffini is sufficient to confirm what I said. He described an anencephalic embryo with spina bifida in which the body instead of taking the normal curvature had remained rectilinear.

#### REFERENCES

1. ALDROVANDI, U. *Monstrorum historia*. Bononiae, 1642, p. 461.
2. MECKEL, J. F. *Handbuch der pathologischen Anatomie*. Leipzig, 1812, Vol. 1, p. 195.
3. HOFFMANN, M. *Ephemerid. naturae curios.* 1671. Decur. 1, Year 11, Obs. 36.
4. KERKING. *Spicilegium*. Amstelodami, 1670, p. 59, tav. 9.
5. SANDIFORT. *Anatome infantis cerebro destituti*. Ludguni Batavorum, 1784, p. 27.
6. MALACARNE, V. *Mem. della Soc. Ital., Modena*, 12: pt. 2, 173, 1805.
7. GEOFFROY SAINT-HILAIRE, L. *Des anomalies*. Bruxelles, 1832.
8. FORSTER, A. *Die Missbildungen des Menschen*. Jena, 1861, p. 78, tav. xiv.
9. BAUER. *Untersuchungen über den Schädel der Hemicephalen mit besonderer Berücksichtigung der Fersenbein*. Marburg, 1836.
10. TARUFFI. *Storia della teratologia*. Bologna, 1891, Vol. 4, Part 1.
11. SCHLEGEL. *Aenecephalorum historiam originemque*. Berolini, 1812.
12. MELLI, J. *Arte Medico-Chirurgica*. Venezia, 1732, Part 11, disp. iii, p. 207.
13. DÖVEREN. *Specimen observationem academicarum*. Groningae, 1765, cap. 11, p. 46.
14. GADDI, P. *Gaz. Med.-Italiana*, Milano, p. 21, 1855.
15. RECKLINGHAUSEN. *Virchows Arch.*, 105: 301, 1886.
16. MUSCATELLO. *Studi sul Cefalocele e sulla spina bifida*. Catania, 1900.
17. ZINGERLE. *Arch. f. Entwickl. Mech.*, 14: 1902.
18. VERAGUTH. *Ueber das innere Ohr bei anencephalie*. *Neurol. Centralbl.*, 1898; *Arch. f. Entwickl. Mech.*, 12: 1901.
19. HALLER, A. *Opuscula anatomica*. Gottingae, 1751, p. 290.
20. DARESTE, J. *Sur la production artificielle des monstruosité's*. Paris, 1877, p. 246. *Compt.-rend. Acad. d. Sc.* 89: 1402, 1877.
21. LEBEDEFF. *Virchows Archiv.*, 86: 263, 1890.
22. DUCHATEAU. *J. compl. d. Sc. méd. Paris*, 8: 337, 1820.
23. FALDINI, G. *Un caso di spina bifida in un feto al quinto mese di vita intrauterina*. *Chir. d. organi di mov.* 7: fasc. 5-6, 1923.
24. PUTTI, V. *Die angeborenen Deformitäten der Wirbelsäule*. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 14: 285, 1909; 15: 65-243, 1910.
25. RUFFINI, A. *Fisiogenia*. Milano, Vallardi, 1926.

# THEORIES OF MYCOSIS FUNGOIDES, HODGKIN'S DISEASE, ETC.

WITH TWO CASE REPORTS\*

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## INTRODUCTION

DURING recent years considerable discussion has arisen regarding the interpretation of the diseases of lymphatic origin. A definite classification is difficult because the exact nature of the changes occurring in this group of diseases is unknown. While we recognize a rather distant relationship among the leucemias, Hodgkin's disease, lymphosarcoma and mycosis fungoides we hesitate to accept the last mentioned as skin manifestations of tumor overgrowths of the blood forming reticulo-endothelium. It is further rather difficult to accept the hypothesis that Hodgkin's disease is neoplastic in origin. Reid,<sup>1</sup> Longscope,<sup>2</sup> and Bunting and Yates<sup>3</sup> were of the opinion that the etiologic factor in Hodgkin's would be found to be an infectious rather than a neoplastic process. Ewing<sup>4</sup> cites the fact that he has seen leucemic processes develop from pneumonia and acute tonsillitis. Jaffe<sup>5</sup> is of the opinion that some acute leucemias, especially in the young, follow the opening of a chronic focal infection such as pulling a tooth. Ewing<sup>6</sup> further states, "The more generalized forms of lymphosarcoma are not frequently the sequel of pseudoleucemia or leucemia, for which an infectious origin is probable. The usual type of sarcoma following Hodgkin's granuloma has a specific structure which differs from that of lymphosarcoma." Karsner,<sup>7</sup> in referring to mycosis fungoides, definitely states, "It was originally thought to be a variety of sarcoma but is now considered inflammatory."

Keim,<sup>8</sup> on the other hand, made reference to the interpretation of this lymphatic group and offered the suggestion that the multiple clinical pictures of the various forms of lymphadenosis should be termed the lymphoblastomas because of the genetic relationships which exist between the forms listed under the diseases of lymphatic origin. His inference was that they are all neoplastic in nature, and are merely different manifestations of the same disease.

## MYCOSIS FUNGOIDES

*Clinical Interpretation:* From a clinical point of view it seems plausible to accept infection as a greater probability than neoplasm as the basic factor in mycosis fungoides. The early stage of this disease is a dermatitis, at first mild, eczematoid in type and may follow a very prolonged course. These skin manifestations often change in form, become dry or moist, scaly, improve and reappear in a worse state. The disease presents a variable picture such as may be expected in an infectious process. In the second stage very early nodulation, in the form of papules and pigmentations, is seen. The individual papule or small nodule may disappear and others reappear either at the same or different sites, a process which seems unusual of a true newgrowth, unusual because a true tumor, while it metastasizes extensively to other parts of the body and may not be progressive at the focal point of origin, does not disappear at the original point. In the third stage there is definite formation of

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nodules which may simulate tumors in that they sometimes become very large. In the case we here present several of these

there is nodular formation, if this were a true tumor, we should expect to find some definite tumor cell, but instead we



FIG. 1. Tumor-like nodules of mycosis fungoides, reappearing and breaking down.

nodules measured as much as 7 cm. in diameter. Even where definite nodules had already been formed we found some to disappear entirely, sometimes reappearing while others appeared at new sites. These nodular lesions tend to break down and ulcerate, changing the node to a large crater-like lesion, with a deep ulcerated base and raised, indurated edges. While the disease is fatal we could not call it malignant, if it were a tumor, because its manifestations of appearance, disappearance and reappearance could not be termed metastasis. The breaking down with sloughing and ulceration of the nodules, some of which may heal while newer lesions follow the same course, seems to present a picture which is not grossly characteristic of any tumor. It tends to simulate the chronic granulomatous picture of infection rather than newgrowth.

**Histological Interpretation:** Histologically, too, there is very little evidence of newgrowth in the sense of tumor tissue. In the earlier stages there is seen a thickening of the epidermis and prolongation of the interpapillary portion. Infiltrating the corium are many lymphoid cells together with a few plasma cells and young, new growing fibroblasts. These are the cells seen in chronic inflammatory processes, particularly in the granulomatous type. In the later stages when



FIG. 2. Section through broken down lesion of mycosis fungoides showing surface epithelium.

find almost all the cells of inflammation. Section of the nodule presents leucocytes, lymphocytes, young fibroblasts, eosinophiles, plasma cells and giant cells. Many of the plasma and round cells show a tendency toward giant cell formation and numerous mitotic figures are seen. The large oval cells of lymphoid type do present somewhat of a sarcomatoid picture but lack the invasive and malignant tendency of a fatal tumor.

#### CASE REPORT

The case presented was referred by Dr. J. C. McNutt whose cooperation enabled the case work-up. It is that of a boy twenty years old, who since the age of nine has had spasmodic skin eruptions of a very varied nature, occurring almost anywhere on the body, but heavier on the lower extremities. For about the first five years it was considered some sort of eczema which "would come and go." It was always worse in the summer and was aggravated when exposed to the sun. As the disease progressed

it was noticed that the individual eruption became thicker and as it disappeared left a discolored area. Reappearance, either in the

do, that this disease is fatal. The clinical appearance before nodule formation, and the histological section of the nodule, while



FIG. 3. Growths of mycosis fungoides. Three tumor-like nodes, one completely broken down and ulcerated and one in the process of breaking down, three adjacent ones intact.

same spot or elsewhere, within the last two years, was in the form of small elevations. About six months ago many of these small elevations became very large nodules, especially several on the right leg, while others disappeared. Up to this time many different dermatologists had seen him and the diagnosis of a different infection varied with each consultant. Syphilis had held sway for about a year prior to this and he had been given large doses of potassium iodide and a course of salvarsan. At this time the diagnosis of infected skin cysts, of the right leg, was made and an incision revealed only a soft surface and a small amount of serum and a watery-like, hemorrhagic fluid. Within a short time the center of one large nodule, on the right leg, began to ulcerate, while an adjacent one disappeared, and several new ones appeared on the abdomen. When he presented himself for examination the right leg was the seat of five large nodules, the largest measuring 7 cm. in diameter, and ulcerated as shown in Figure 3.

Histological examination of an area through the edge of the ulcerating nodule revealed the findings referred to as mycosis fungoides. As shown in Figure 2, many large, oval cells of the lymphoid type, together with cells of inflammatory nature, are seen beneath the surface epithelium.

This clinical history of appearance, disappearance and reappearance of nodules at the same or different sites, is not in accord with the history of tumor, knowing as we



FIG. 4. Extensive fibrosis and hyalinization in case of Hodgkin's disease. The typical large cells completely set off from fibrosis

not definitely inflammatory in character, tend more to infection than neoplasm.

#### HODGKIN'S DISEASE

*Clinical Interpretation:* In this progressively fatal disease there is very little clinical evidence that might lead one to tend either toward infection or tumor as an etiological basis. In favor of the latter we find only the progressive, painless enlargement of the various lymph glands. In favor of infection stands the work of Bunting and Yates, and others who have isolated from, and associated certain organisms with many cases of Hodgkin's disease. In addition to this a close relationship between Hodgkin's disease and tuberculosis has long been recognized and a similar relationship to the leucemias seems to exist. In associating the leucemias with infection stands out the very grave proba-

bility that many cases of leucemia, as well as forms of agranulocytosis, seem to have their origin in the sudden opening of some



FIG. 5. Typical large cells of Hodgkin's disease and beginning focal necrosis in lower left corner.

focus of infection; as previously cited the development of acute leucemia in younger individuals, especially children, has followed the pulling of an abscessed tooth. It is well established that in response to stimulation by an infection there is a normal outpouring of white cells to combat the foreign invasion. This response is considered the normal capacity in which the blood forming elements function. It may further be assumed that in agranulocytosis there is a decreased response with great lack of white cells, while in leucemia there is an increased response with great overgrowth of white cells.

*Histological Interpretation:* Histologically the picture is a varied one, varying accord-

ing to the stage of the disease. The early changes noted are hyperplasia and proliferation of the lymph cells which obscure or obliterate the normal markings. The germinal centers and endothelial cells of the sinuses also show extensive hyperplasia. As the disease progresses the normal markings are completely obliterated and a characteristic cell picture is seen; marked hyperplasia of lymphoid cells, numerous plasma cells, endothelial cells, eosinophiles and many very large, multinuclear giant cells. These cells are irregularly intermingled as in mycosis fungoides except that the very large giant cells are more prominent and characteristic of Hodgkin's disease. There is usually only slight, if any, fibrosis until the late stages when fibrosis usually forms a prominent part of the picture. Necrosis in very small areas also appears and this, together with fibrosis engrafted upon extensive hyperplasia, tends somewhat toward the infectious theory. Definite newgrowths with invasive tendency such as would tend to the tumor theory are difficult of interpretation.

#### CASE REPORT

The case here presented is that of a young man twenty-four years of age who, about three years ago, received a blow on the right side of the neck, which confined him to bed for three or four days. About six months later a nodule about the size of a walnut was noticed at the site of injury. It was entirely painless and one year later it had attained the size of a lemon. At this time a biopsy was made at the Mayo Clinic, Rochester, with the following report: "Chronic inflammatory process with marked fibrosis and hyalinization." For the following year or more the growth seemed stationary and was symptomless. Within the last few months it again began to enlarge and he presented himself for examination revealing a rather firm, rounded mass in the right supraclavicular region. Blood examination revealed a total white count of 9700 with a polymorphonuclear count of 82 per cent, a comparatively high count. The entire gland was removed and

microscopic section, as shown in Figures 4 and 5, revealed a Hodgkin's lymphogranuloma.

While this patient gives a history of an injury, at the site of original glandular enlargement, we doubt its importance; trauma is not a forerunner of Hodgkin's disease. The early findings of "chronic inflammatory process" after the disease had been in progress for about a year does lend somewhat toward the infectious theory as a possible cause.

#### CONCLUSIONS

The diseases of lymphatic origin, called lymphadenosis, while in some way related, are difficult to classify, because the etiology of, and changes occurring in these diseases are unknown.

The marked primary lymphoid hyperplasia, which lacks the destructive character and invasive tendency of malignancy,

leads us to believe that these diseases are not true tumors.

The general picture of cells and fibrosis which are akin to those of inflammation, lends evidence toward the theory that these diseases are infectious in origin.

Compared to the normal capacity of the body to produce an increased number of white cells in response to infection, it may be assumed that in agranulocytosis there is a decreased response with great lack of leucocytes, while in leucemia there is an increased response with great overgrowth of leucocytes.

Mycosis fungoides and Hodgkin's disease are here discussed and while both these diseases are fatal, true metastasis cannot be established; the term malignant tumor cannot, therefore, be properly applied.

The clinical and histological pictures in these cases seem to favor infection rather than tumor as the basic etiology.

#### REFERENCES

1. REED, D. M. On the pathological changes in Hodgkin's disease with especial reference to its relation to tuberculosis. *John Hopkins Hosp. Rep.*, 10: 133, 1902.
2. LONGSCOPE, W. T. On the pathological histology of Hodgkin's disease with a report of a series of cases. *Bull. Ayer Clin. Lab. Penna. Hosp. No. 1*, P. 4. 1903; Hodgkin's Disease, In: Osler and McCrae's Modern Medicine. Phila., 1915. 4: 755.
3. BUNTING, C. H., and YATES, J. L. Various studies of Hodgkin's disease. *Arch. Int. Med.*, 12: 236, 1912; *J. A. M. A.*, 61: 1803, 1913.]
4. EWING, J. Scientific proceedings of the twenty-seventh annual meeting of the American Association of Pathology and Bacteriology. *Am. J. Path.*, 3: 551, 1927.
5. JAFFE, R. H. Stated at Clinical Pathological Conference, Cook County Hosp., Chicago, Ill.
6. EWING, J. Neoplastic Diseases. Etiology of Lymphosarcoma. Phila., Saunders, 1919, 375.
7. KARSNER, H. T. Mycosis Fungoides, Human Pathology. Phila, J. B. Lippincott, 1926, 298.
8. KEIM, H. L. Universal leukemia cutis. *Arch. Dermat. & Syph.*, 10: 579, 1924.





# THE PROSTATIC HARPOON

## A NEW TRACTOR FOR SUPRAPUBIC PROSTATECTOMY\*

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THERE are several factors which characterize a satisfactory technique for any surgical operation and it is

Safety in prostatectomy is dependent upon a number of factors aside from the operative technique so that only the

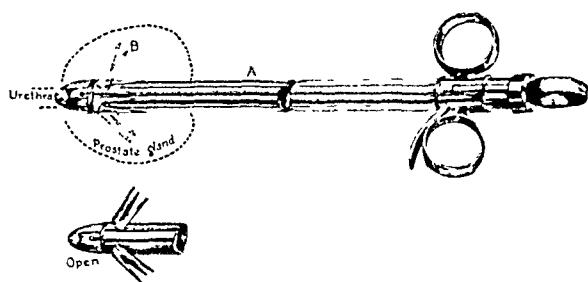


FIG. 1.

difficult to evaluate them from the standpoint of their relative importance since in the various operations of surgery we set about to accomplish so many different purposes.

Considered technically it would seem that the operation for removal of the enlarged prostate should combine speed, facility and insofar as possible complete visibility to insure a good functional result.

Speed is important because of the age and debilitation of the patient which make him as a rule a poor subject for any prolonged procedure; facility because it is only by use of the easier technical methods that the average surgeon can attain swift, sure perfection; complete visibility of the structures attacked in order that a clean dissection may be carried out without danger of damage to important tissues adjacent.

As regards the functional result there is perhaps no place where it is more important than in the patient suffering from prostatism, and aside from safety this is usually the patient's chief consideration.

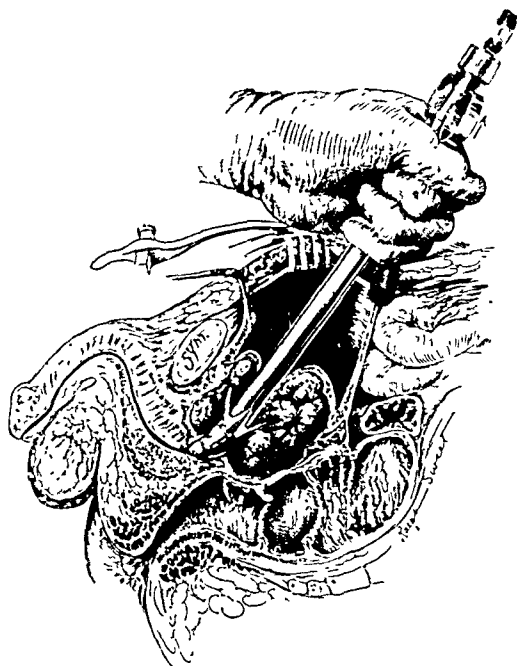


FIG. 2.

operative side will be considered here. It is fair to assume however that a method combining speed, facility and good visibility would be a safe procedure as well.

The technique presented here has come about through the development of a new instrument designed by the author and called the prostatic harpoon.

The instrument consists of a hollow tube into which slides a shaft operating a pair of opposed three-toothed curved jaws. These are activated by a swiveled thumb ring and a pair of finger rings at the opposite end of the tube. The thumb ring is integral with a shaft sliding within the tube. A lock operated by the finger

\* Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, November 18, 1931.

holds the jaws in the open or closed position. When closed the jaws fit snugly against the side of the tube. A centimeter scale is embossed along the side of the tube.

The technique of its use is as follows: With the patient in Trendelenburg position the bladder is opened in the usual manner and a self-retaining retractor adjusted. The instrument, held in the right hand with jaws horizontal, is passed down the prostatic urethra until the tip is at the apex of the gland. The jaws are thrown open and buried in the lateral lobes where they are locked in position. Traction is put on the instrument with the left hand and the gland lifted upward into the floor of the bladder. Dissection is begun with scalpel down to the line of cleavage, as shown, and carried to completion with long handled Mayo scissors under direct vision. As the jaws open only laterally, there is no danger of injuring the rectum posteriorly or the plexus anteriorly. The jaws being curved and set at a little less than a right angle when fully open tend to hold the gland more and more firmly instead of tearing out as more traction is applied. The tractor can be easily released, however, if for any reason it is desired to remove it before the dissection is complete.

Several definite advantages are noted in the use of the instrument: First, the gland is so firmly grasped that it is surprisingly mobile and can be swung upward and from side to side for carrying out the dissection with great ease.

The traction tends to reduce hemorrhage to a minimum so that little sponging is necessary and further there is no need for the use of the finger in the rectum either

as a guide or to elevate the gland since by throwing the handle of the instrument downward over the symphysis the posterior

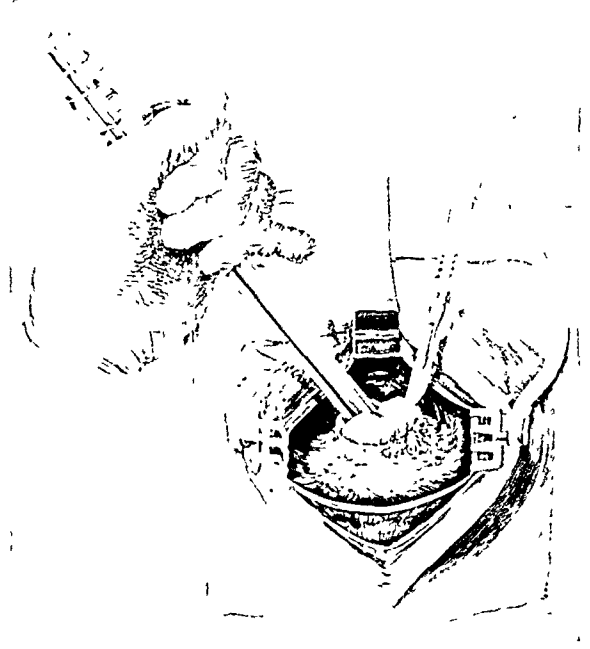


FIG. 3.

surface is easily brought into view and the line of cleavage at all times visualized.

In the development of any new instrument or technical procedure it is frequently difficult to prevent our enthusiasm from carrying us into extravagant claims in the way of results. These results are all too often based on too small a series of cases.

In this preliminary report embracing a relatively small series it is perhaps best to withhold actual statistics lest they appear misleading and simply state that in our hands thus far results have been uniformly better and the method has proven simpler, speedier, and a cleaner procedure than any other used.



# SIMPLIFIED CATHETERIZING CYSTOSCOPE\*

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THIS instrument consists of two parts ; The telescope gives a forward and a telescope and a sheath. The sheath is oval, 22 French, and divided into slightly downward view, and carries a light at the vesical end.

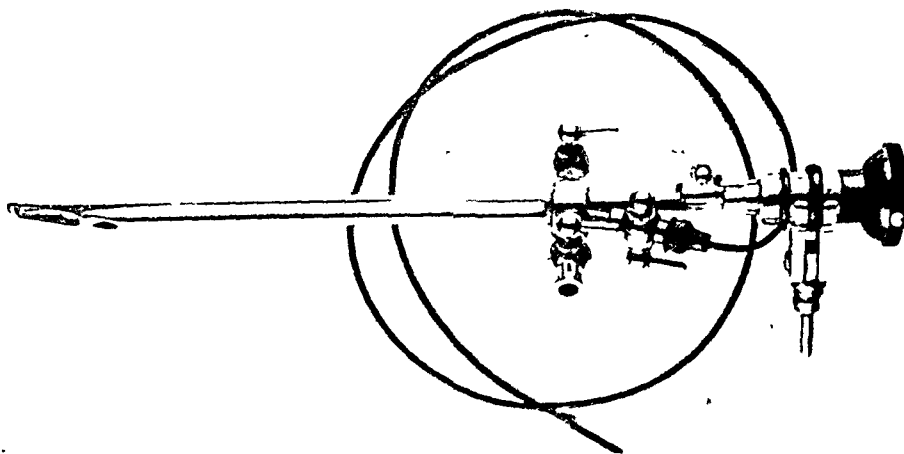


FIG. 1.

an upper and a lower channel. The upper channel carries the telescope, which is removable, and is held in place by a clamping screw. The lower channel is for the catheter or bougie, and sizes up to 8 French can be used. At the vesical end the channel is so arranged that the emerging catheter is given a slightly downward inclination. At the outer end of the channel is a stopcock that prevents leakage when the instrument is used without the catheter, and that permits the introduction of the catheter (or change of catheters) without the loss of bladder fluid. Connecting with the lower channel is another stopcock used for filling and irrigating.

The beak of the instrument is bevelled obliquely; it is smooth and can be introduced with a minimum of discomfort, and without injury; there is no damage done by moving the instrument in the bladder.

This instrument was devised primarily for renal lavage, and the making of pyeloureterograms, for which it has been found most satisfactory. It is easily introduced into the bladder, can be manipulated without discomfort, and the catheters are introduced into the ureters with a minimum resistance. There is no discomfort to the removal of the instrument and leaving the catheter in situ.

The catheter canal is sufficiently large to use a No. 6 catheter which has been waxed. The technique is to push the catheter 4 to 5 in. beyond the tip of the instrument, to wax it, and then retract it into the canal.

The advantages claimed are simplicity, comfort to the patient, ease of manipulation, and that the sheath can be boiled.

It is planned to make an extra sheath to carry two catheters that can be used with the present telescope.

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

## EDITORIALS

### PROGNOSIS: STOP, THINK, THEN SPEAK!

WHILE reading in a dentist's office recently, I saw the following in the December 1930 issue of the *Christian Science Journal* under the heading of Testimonials of Healing; "It is with a deep sense of gratitude that I verify the statements made by my brother-in-law in the above testimony regarding my healing from cancer through Christian Science Treatment."

I wonder who of us has not had a kindred experience? Few of us perhaps who have not seen at least one patient profoundly ill sometimes with what we took to be carcinoma, whom we were unable to thoroughly study for one or another reason. This same patient's family in

desperation (even as you and I would be, were we laymen with a seriously ill relative) and disgusted with the doctor's inability to work a miracle, have then seized upon a ray of hope in the form of a kindly neighbor's advice and have consulted an irregular practitioner. Then the patient starts to pick up in vigor and in spirits. He may go on to recovery or he may not. If he recovers the cult gets credit for a miracle. If he does not recover, after showing the initial improvement, then, "it was too bad the cultist was not consulted sooner. He did do a lot, but the patient came too late." All of us know that many diseases, even in extremis, have astounding remissions which often piti-

fully instill hope in the family. We can warn the family of the likelihood of this. All of us know too, that the panicky family often takes the ridiculous advice of friends in preference to the scientific, honest advice of their physician. There is little we can do to offset this frailty of human nature.

But there are a few things we can, and should, do to prevent these wild stories getting into circulation, about the miracles of the cults and the deficiencies of our profession. First we can be extremely careful of our diagnosis, and secondly even more careful of our prognosis.

Perhaps at no time in the history of the world has the public been so health conscious. Look through your favorite magazine and see how much of the advertising has a health angle. It is astonishing. It is often amusing and sometimes shocking to have patients repeat to me their impossible interpretation of a conversation with one of my colleagues. We must realize that when a patient or his family asks us a question that they are in no mind at that time, if ever, to properly evaluate a technical discussion. We should be doubly careful in our conversation with a patient or his family lest they take a simple casual remark and enlarging upon it with their imagination, develop some weird, impossible tale.

It is difficult to impart to medical students just how much to tell patients or their families. Much depends upon the psychic make-up of the family and of the doctor. The hospital physician can better instruct his interne in this matter but much comes only with experience which is often bitter. It is not desirable to give each patient or his family, a lecture on physiopathology or therapeutics, nor is it right to dismiss them with a blank forbidding stare. Hardly with long experience can one develop the knack of saying just enough and just the proper thing.

Prognosis is often an important part of the treatment. A bad prognosis need not be expressed to the patient to have a harmful effect on him. An untimely shake of the head

or an insincere note of optimism is readily detected by even the gravely ill. And too, a bad prognosis expressed to the thoughtless or anxious family is often relayed to the patient either directly or by inference.

We must ever bear in mind that it makes a tremendous difference which side of the desk or bed we are on, whether it is the seeking advice or giving advice side. We should constantly remember that nothing we say to those who seek advice is casual, they are mariners seeking guidance through a dark night, and each remark we make has an important bearing to them, if ever so trivial to us.

Much is being said in the medical meetings and much is being written about how to combat the insidious attack of public distrust that is undermining the age-old citadel of public confidence in the medical profession. Might not one simple, yet important, step be to give greater care to our conversation with patients, to censor our every remark? This is also true of our casual conversation with friends. Some physicians effect an iconoclastic front. Sometimes they indulge in a bantering type of talk with their lay friends about the limitations of the medical profession. Much of their talk may be along therapeutic annihilistic lines. It may be in jest or it may be serious. But certainly the germ of an idea is planted that almost invariably acts as a boomerang to the originator. Often he would be unable to recognize his idea, were he to inadvertently stumble upon it, in its fifth revision by friends of friends of his friends to whom he talked, in semi-confidence. It is possible that this so called "small talk" may be an important factor in the present day semi-suspicious relations of the public to the physician, about which we hear so much. A little more thought to our casual talk with the non-medical public and to our serious talk to patients and their family might go a long way to eradicate, at least in part, the present day tongue-in-the-cheek public-to-doctor attitude.

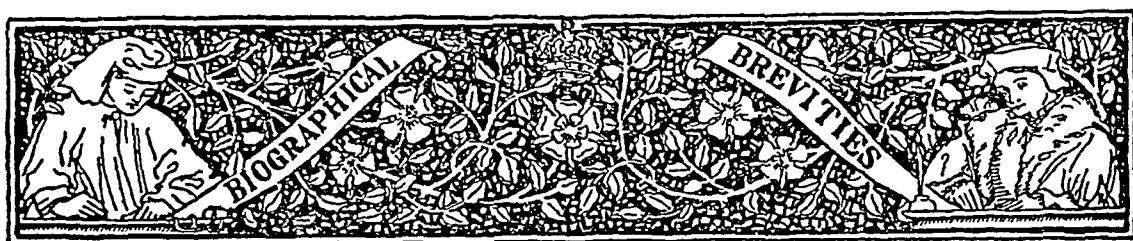
HILTON S. READ, M.D.





JOHN JONES

[1729-1791]



## AMERICAN PHYSICIANS

### JOHN JONES

**J**OHN JONES was born at Jamaica, Long Island, in 1729. His ancestors were Welch and Pennsylvania Quakers.

After a preliminary education in private schools in New York, he decided to become a physician and became apprenticed to a relative, Dr. Cadwalader of Philadelphia. After three years in Philadelphia he went to Europe and studied under John Hunter and Percival Pott. A year later Jones studied under Petit and Le Dran in Paris. Petit was the inventor of the screw tourniquet and of improvements in the technique of amputations. This training stood Jones in good stead later in his military experiences. Jones also did anatomical work with the elder Monro at Edinburgh. He got his degree in medicine from the University of Rheims, and returned to New York to practice.

He was the first to do the operation of lithotomy in New York. His fame spread and soon he had a large practice. He was one of the first in this country to limit his work to surgery. In addition, being an accomplished obstetrician, he continued his interest in this branch.

Jones became surgeon to the American troops during the French and Indian War, earned great fame, so much so that when Baron Dieskau was wounded and captured at Lake George, he pleaded to be put under Dr. Jones' care.

When King's College (now Columbia University) was organized in 1768 Dr. Jones was appointed professor of surgery. He also lectured on obstetrics. In 1775, he

published "Plain Remarks Upon Wounds and Fractures." It was reprinted in 1776. This was the first American book on surgery. The introduction was addressed "to the students and young practitioners of all America," and, in a foreword Dr. Jones writes that the work is not a studied, systematic treatise on surgery but "remarks and observations, thrown together under the disadvantageous circumstances of ill health, and a variety of occupations which allowed little leisure for composition."

When the British army took possession of New York, Dr. Jones left the city. For a while he had a seat in the State Senate, then he entered the medical department of the army. Ill health compelled him to return to civil duty. He went to Philadelphia, found relief from the asthma there, and became a permanent resident in 1779. The next year he succeeded Dr. John Redman as one of the physicians of the Pennsylvania Hospital. He was the first president of the humane society, a consulting physician of the Philadelphia Dispensary, and, in 1786, was elected the first vice-president of the College of Physicians of Philadelphia, which office he occupied until his death.

Dr. Jones was a friend and physician to Benjamin Franklin and attended him in his last illness. In 1790 he went to New York to consult in the case of George Washington, and was later his family physician in Philadelphia.

Dr. Jones died in 1791.





[From Fernelius' *Universa Medicina*, Geneva, 1679.]

# BOOKSHELF BROWSING

## KIDNEY DISEASE AND ANIMAL EXPERIMENTATION\*

FRANKLIN R. NUZUM, M.D.

SANTA BARBARA, CALIF.

**E**LEVEN per cent of adults are dying of chronic Bright's disease. This condition is closely related pathologically with chronic heart disease of the hypertensive type and with cerebral hemorrhage. This triad accounted for 45.5 per cent of the deaths of adults in the Registration Area of the United States in 1928.<sup>1</sup> The importance of chronic kidney disease as a deterrent to further increasing the span of life is apparent.

In this article it is proposed to point out the slow manner in which our knowledge of kidney disease has been accumulated. A summary of our present knowledge will be given and a survey of tasks that remain. The importance of experimental animals in gaining our present knowledge of the kidney and its functions will be indicated.

The first description of kidney disease, so far as we know, is found in the works of Aetius (500 A.D.). He found, as the result of autopsies on human beings, that certain cases of swelling of the legs and of free fluid in the abdominal cavity, i.e., dropsy, were associated with hardening of the kidneys.<sup>2</sup> No further advance was made for 400 years until Avicenna (980-1036), a clinical observer, noted that in dropsy the

urine was thin, watery and increased in density.<sup>3</sup> Further progress does not appear for another 650 years, until the time of Marcello Malpighi (1628-1694), an Italian. Up to his time practically nothing was known of the structure of the kidney. William Harvey (1578-1657), of England, in 1628 published his discovery of the circulation of the blood. He found that the blood was forced by the heart through the arteries and that it returned to the heart through the veins. He was uncertain, however, as to how the blood flowed from the arteries to the veins. This was shown by Malpighi, who used more powerful magnifying glasses than were known to Harvey. With these lenses he traced the blood through the capillaries and demonstrated that the capillaries conducted the blood from the arteries to the veins. The epochal work of Harvey and Malpighi established physiology on a scientific basis. In addition to Malpighi's discovery of the function of the capillaries, he laid the groundwork for a more accurate knowledge of the kidney. His name is associated with the tiny filters of the kidney, the Malpighian corpuscles or glomeruli.

\*This is the third of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.

Giovanni Battista Morgagni (1682–1771) further advanced our knowledge of the kidney by a careful clinical and anatomical study of the chronic type of kidney disease that is associated with dropsy, as indicated by swelling of the extremities and the face and fluid in the abdominal cavity. He found, in studying dropsies, which attracted particular attention at that time, that some instances of dropsy occurred in kidney disease and some in liver disease.<sup>4</sup> He was the first to show that dropsy might result from more than one cause. Ten years later (1770) Domenico Cotugno (1736–1822) first recorded the presence of serum-albumin in the urine of patients with dropsy.<sup>5</sup> William C. Cruikshank (1745–1800) went a step further and in 1790 reported that certain instances of dropsy had no albumin in the urine.<sup>6</sup> William C. Wells (1757–1818) of Charleston, S. C., demonstrated the presence of blood and albumin in the urine of patients with dropsy following scarlet fever. This acute type of kidney disease had never before been described.<sup>7</sup>

Forty years passed before Richard Bright (1789–1858), an Englishman, carried on his epochal work, which covered the relation of dropsy, kidney disease and liver disease.<sup>8</sup> He also found that certain types of dropsy were associated with liver disease, certain others with kidney disease. He described the enlargement of the heart which occurs in some forms of kidney disease, that is, the enlargement of the heart associated with high blood pressure. Bright divided kidney disease into three groups. His descriptions are as accurate and as instructive as any that have since been written. Nephritis is commonly called Bright's disease in honor of the discoveries of this great investigator.

Following Bright's work a further study and description of the various kinds of kidney disease was undertaken. Christison placed special emphasis upon acute and chronic types.<sup>9</sup> He found that kidney disease suppressed the solids of the urine and was frequently accompanied with a

severe anemia. Graves raised an objection.<sup>10</sup> He regarded kidney lesions not as the cause but as the result of dropsy. He held that

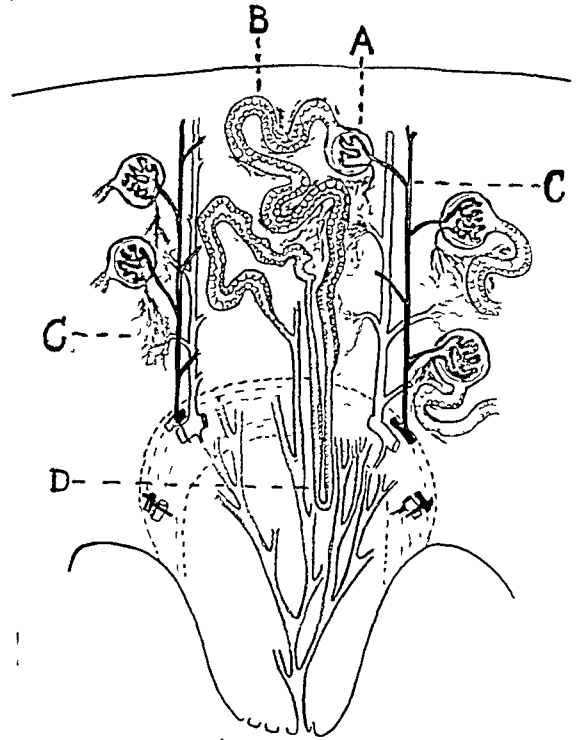


FIG. 1. Schematic diagram of kidney. A, Glomerular tufts. B, Tubules. C, Blood vessels. D, Loops of Henle. (From Oertel: *The Anatomic and Histological Processes in Bright's Diseases*.)

the efforts of the kidney to remove the dropsical fluid from the body were the cause of the disease. This objection was long ago shown to be erroneous.

From England the study of kidney disease spread to France. Rayer emphasized Bright's contention that nephritis was an inflammatory condition of the kidney, a point of special importance in considering the causes of this group of conditions.<sup>11</sup> He gave an accurate description of the urine in nephritis. Solon in 1838 coined the term "albuminuria," albumin in the urine.<sup>12</sup> This term is in general use at the present time, and is the most important factor in making a diagnosis of kidney disease. Solon made one more important discovery in his clinical work: Up to that time it was thought that practically all

persons with kidney disease had dropsy. He found that granular kidney, that is, that type of kidney disease frequently

was the first to give an accurate description of casts, definitely shaped albuminous structures found in the urine of persons

## BOWMAN'S THEORY OF URINE FORMATION

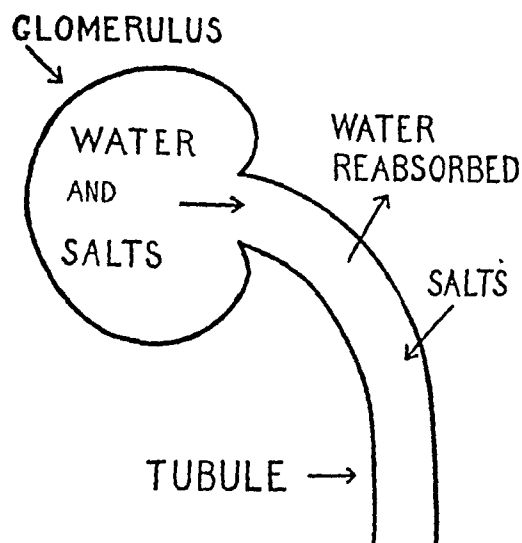


FIG. 2.

associated with high blood pressure, often occurred without dropsy. Becquerel, another Frenchman, published a paper in 1841 on the alterations in the urine in certain maladies, among them Bright's disease.<sup>13</sup> He was the first to give detailed attention to the finer histological structure of the kidney. He concluded that the Malpighian corpuscles were the secreting units and that Bright's disease was due to an enlargement of these units. This conclusion is erroneous.

While work on kidney disease was progressing in England and France, great advances in physiology were being made in Germany. The Germans had developed the most powerful microscopes, and were quick to avail themselves of this help in the study of the tissues of the body. They made many important discoveries. Those about nephritis were especially noteworthy. In 1841 the anatomist Henle published his work on the structure of the kidney.<sup>14</sup> Many of his findings are still authoritative. He outlined the types of kidney disease and

## LUDWIG'S THEORY OF URINE FORMATION

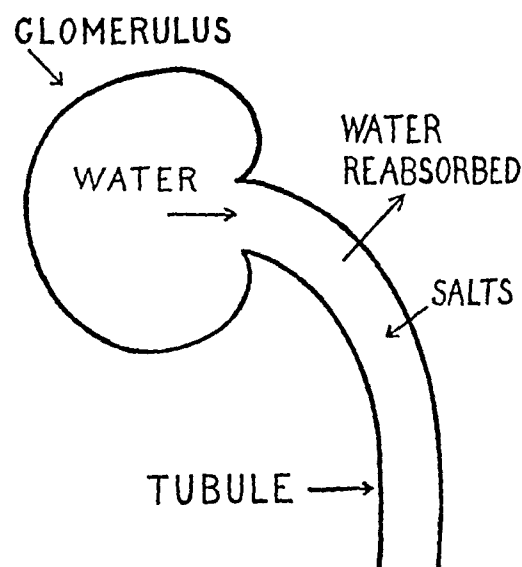


FIG. 3.

with nephritis. Their presence, together with a positive test for albumin, is the principal reliance of physicians in diagnosing nephritis.

About this time Toynbee in England found a thickening of the walls of the arteries in the kidneys in certain types of kidney disease.<sup>15</sup> Present-day conceptions of the form of chronic kidney disease associated with increased blood pressure place special emphasis upon this thickening of the walls of the arteries of smallest caliber, the arterioles. This change is present so frequently that the type of chronic nephritis associated with increased blood pressure is popularly spoken of as that type due to blood vessel disease of the kidney. For many years there have been two schools, one that held that the thickening of the blood vessel walls in the kidney was the cause of the high blood pressure, and the other that the high blood pressure was the cause of thickening of the vessel walls. More recently, the general concep-

tion of this relationship is as follows: Continued spasm or contraction of these small blood vessels, not only in the kidney but throughout the body, results in an increased blood pressure and the latter causes an ultimate change or thickening of the blood vessel walls.

This leads to a still different plan of classifying the different types of nephritis: the blood vessel type, the interstitial or connective tissue type, and the type involving the epithelial cells lining the convoluted tubules, the so-called parenchymatous type. Virchow (1852) was the first to use this term.<sup>16</sup> One of his pupils, Niemann, gave an excellent description of parenchymatous changes in kidney disease. Another of his students, Beer (1859) described the connective tissue changes in the various kinds of nephritis and attempted to relate them to the accompanying blood vessel and parenchymatous changes previously described by others. Klebs (1880) established as a special kind of nephritis that group characterized by particular changes in the filters, or glomeruli, and known since as glomerulonephritis.<sup>17</sup>

Intensive studies of the physiology of the kidney began forty years prior to Klebs' publications. In 1842, Bowman, in England, published the result of his studies on the structure of the kidney. He described the delicate membrane that surrounds the Malpighian corpuscles and connects them with the convoluted tubules. A schematic outline serves best to illustrate the structure of the kidney as understood in Bowman's time (Fig. 1). This conception is still held.

Until this time, 1842, knowledge of the structure and functions of the kidney had been obtained chiefly from a study of human kidneys. These studies had been anatomical. The functions of the kidney now became the more important field for research. Bowman, using both human and animal subjects for study, summarized what was known of the physiology of the kidney and propounded the first widely recognized theory of urinary secretion.<sup>18</sup>

The structure of the capsule and the glomerulus suggested to Bowman that here was a true filtering apparatus from

## CUSHNY'S THEORY OF URINE FORMATION

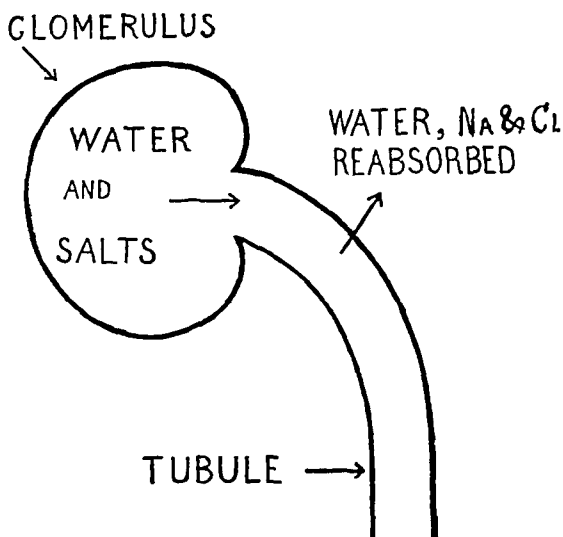


FIG. 4.

which the water of the urine is filtered from the blood. "It would be difficult to conceive a disposition of parts more calculated to favour the escape of water from the blood than that of the Malpighian body . . . Why is so wonderful an apparatus placed at the extremity of each uriniferous tube if not to furnish water to aid in the separation and solution of the uriniferous products from the epithelium of the tube."<sup>18</sup> Bowman did not state clearly where the ordinary salts of the urine were secreted, but implied that they too passed through the capillaries (fine blood vessels) in the glomerular (Malpighian) corpuscle or tuft. Thus was born the first theory of the way in which the kidney secretes urine.

Two years later (1844) Ludwig put forward another theory of the secretion of urine.<sup>19</sup> He too used both human and animal material in his studies. He held that the capsule enclosing the glomerulus, or Malpighian tuft, was a simple filter

which allowed the diffusion into the tubule of all of the fluid elements of the urine. To the single layer of epithelial cells lining the convoluted tubules was ascribed the function of secreting such products as urea, uric acid and salts. These were washed down the tubule by the fluid from the glomerular tufts and finally expelled as urine.

Up to this time practically all of the important observations that had been made on the various phases of kidney disease were the result of study of these conditions in human beings. Some observations had been made on animals. Animal experimentation, commonly known as vivisection, was probably founded by Galen. He made extensive studies of this kind.<sup>20</sup> Since Galen's time, an occasional great scientist had used vivisection in pursuing special studies. Magendie (about 1830) established vivisection on a firm foundation in physiological studies. His pupil, Claude Bernard, one of the greatest of physiologists, made fundamentally important studies upon the functions of the kidney by means of experiment. These studies were published in 1856, 1858 and 1859. They had to do with the reduction of the urine of animals on special diets; with the way the blood eliminated certain injected substances in the urine, etc. G. Simon, in 1871, published some of the earliest observations on the effect of the removal of one kidney. In three adults in whom one kidney had been destroyed as a result of disease the remaining kidney was found to have enlarged to twice its normal size. He removed one kidney from each of eight dogs. He found that the remaining kidney enlarged in seven of the eight experimental animals. This enlargement he described as due to an actual increase in the number of glomeruli and tubules, since microscopically he could see no difference between the size of these structures as compared with the normal. He did not find an increase in the size of the heart of these animals, and concluded that even left-sided enlargement of the heart does not occur if the remaining kidney shows

compensatory growth.<sup>21</sup> This information and these methods of experimental physiology were used by Heidenhain, who in 1874, thirty years after the propounding of Ludwig's theory of urinary secretion, gave the first experimental evidence on this theory. This explanation ascribed the secretion of the urine by the kidneys to the vital activity of their cells.

The advances of physical chemistry in the last twenty-five years have proved the inadequacy of these theories of urinary secretion. By the help of this newer chemistry and of new facts established by animal experimentation, a third or modern view has been elaborated. A monograph was published in 1917 by Cushny, formerly a professor at the University of Michigan, describing this new theory.<sup>22</sup> It is called after his name. In brief, it describes filtration of water and of the other elements of the urine through the glomerular capsule. This process of filtration depends upon several factors, one of which is the blood pressure in the glomerular tufts. The higher the pressure, the greater the opportunity for filtration, and vice versa. Reabsorption of a large amount of fluid takes place in the cells lining the convoluted tubules and depends upon vital activity of the cells themselves. It has been shown by Cushny that probably more than 99 per cent of the fluid secreted by the glomerular tufts, with the urea, uric acid and salts in a very dilute solution, is reabsorbed by the convoluted tube cells. This is shown by the change in the percentage of urea, which can hardly exceed 0.1 per cent in the glomerular filtrate, but which may reach 12 per cent in the urine of the cat. On the reabsorption explanation as offered by Cushny, this means that 120 c.c. of glomerular fluid, containing 0.12 gm. of urea, loses 110 c.c. of water in passing down the tubules, leaving 10 c.c. of urine containing 0.12 gm. of urea. By experimental work, it has also been found that some solids are capable of reabsorption by the tubular cells. Heidenhain was able to show that the

blood of a normal man contained 0.025 per cent of urea and that such a person could excrete in the urine 35 gm. of urea in twenty-four hours. He estimated 0.05 per cent in the glomerular filtrate, and at this rate at least 70 quarts of fluid would have to pass through the glomerular filters in twenty-four hours. Since on the average  $1\frac{1}{2}$  to 2 quarts of urine are passed per day, this means that approximately 68 quarts of fluid are re-absorbed each day by the cells lining the convoluted tubules.

The time and effort that was necessary on the part of Cushny to elaborate the modern theory of urinary secretion was great. At the time of the publication of his first monograph (1917) he had spent some years in laboratory work and had reviewed 6000 pages of discussions and experiments pertaining to this one subject.

The importance of establishing definitely the functions of the various units of the kidney is emphasized in the treatment of human beings who are ill with nephritis. An accurate classification of the various types of nephritis is obviously essential. This has been a most difficult problem, and even today there are objections to the generally used classifications. In each patient ill with nephritis, the clinician attempts by a study of the urine, of the chemistry of the blood, of the ability of the kidney to excrete water, solids and certain dyes, as phenolsulphonphthalein, and by the patient's symptoms, to determine what particular kind of kidney disturbance is present. The greatest difficulty comes in instances in which a combination of types of kidney injury exist at one time. Injury to particular portions of the kidneys of laboratory animals and a study of the urine that is then excreted have helped in a comparative way with studies of the kidneys obtained from patients who during life had had kidney disease. Such comparative studies have been the means of obtaining a satisfactory working classification.

Ribbert (1883), in studying the functions of the renal tubules, eliminated the tubules

in the kidney of a rabbit by gouging them out mechanically.<sup>23</sup> When the kidney healed, he found that the urine was increased in amount and was very dilute. This would tend to confirm the theory that the tubules do reabsorb fluid.

Heidenhain was the first to inject dyes into the circulation and study their manner of elimination.<sup>24</sup> He killed laboratory animals at varying periods after injection and studied the location of the dye in the kidney. He concluded that the dye indigo-carmin was secreted by the cells lining the convoluted tubule. Microscopically, the granules of this dye were found in the cells and in the lumen of the tubules and not elsewhere. To detail the argument that occurred in determining how dye is eliminated, bearing in mind that this was just one means of attempting to determine the function of one part of the kidney, would occupy many pages and would record such well-known names as Wittich (1875), Schmidt (1891), Ribbert (1894), Hober (1895), Basler (1906), and Schafer (1908). Finally Suzuki (1912), after reviewing all of the work that had gone before and as a result of many years of effort on his own part, reached conclusions as follows, which are today accepted as correct: The great mass of an injected dye passes through the capsule of the glomerular tuft in too dilute solution to stain it. In the tubules it becomes concentrated by the withdrawal of fluid. Quite apart from this, the cells of the convoluted tubules show staining of the granules of their interior. This has nothing to do with the elimination of dye, but is probably due to dye derived from the circulating blood being deposited in the granules of the cell. The nerve cells in the kidney are similarly stained from dye in the circulating blood in these experiments. Heidenhain's contention is thus in error; the cells lining the convoluted tubules do not secrete dye. Their function is not secretory, it is absorptive.

The progress of medicine is no better illustrated than by further work in establishing the specific functions of the kidney

by Professor Richards of the University of Pennsylvania and his coworkers, Plant, Schmitt and Wearn.<sup>25</sup> By means of a bright light on the under side of a frog's kidney in situ, the glomerular circulation was observed through a microscope. Dyes were injected into the circulation. The dye of methylene blue was seen to enter the capillaries of the glomerular tuft by way of the small artery that leads to it. It was seen to pass through the capillaries of the tuft into the free space about it and then on down into the tubule. These workers were able to accomplish the seemingly impossible feat of tapping the free space about the glomerular tuft with a capillary tube and obtaining the diluted urine for study, which in this instance contained the dye. Bieter and Hirschfelder, using Richards' method and other dyes, made similar observations.<sup>26</sup> They observed that the dye was always confined to the tubule and that there was no evidence that the cells of the tubule either excreted or absorbed the dye. From the deepening color of the dye in the tubules, they concluded that water is reabsorbed from the tubules.

About the year 1900, a new group of problems in the study of the functions and of the disturbances of the kidney were undertaken. Up to that time, the anatomic structure of this organ had been well worked out and a great deal was known about its various functions, as has been outlined.

The early detection of disease of the kidneys, rather than waiting for late manifestations of such conditions, was then emphasized. Early changes are found most frequently by studies of the urine and by associated studies of the blood. In patients who are found to have kidney damage, the questions arise, what percentage of the kidneys is damaged, how rapidly is the destruction of the kidney progressing, and what is the expectancy of life in these various conditions? To answer such questions, studies of the functional capacity of the kidney were taken up.

Since it has been found by animal experimentation that certain dyes, when injected either into the blood stream or into the subcutaneous tissues, are excreted almost entirely by the kidney, this means of solving such a problem had been carefully studied and, as a result, the Rowntree-Garritty test has come into general clinical use. In this test, given amounts of phenol-sulphonphthalein, a dye, are injected into the blood stream. Its secretion by the kidney begins within ten minutes, and it can be detected in the urine. Within two hours, practically all of the dye has been excreted. In normal individuals, the per cent of the dye excreted is easily determined; in instances in which the kidney is damaged, the excretion of the dye is delayed and only a portion of it is excreted within two hours. In this way, a fair estimate of the functional ability of the kidney can be determined.

The advent of accurate blood chemical methods has led to even more delicate tests concerning the ability of the kidney to function, and has added a great deal of knowledge about the kidney and its functions. By these accurate methods developed within the last fifteen years, it has been found that the substances which are excreted by the kidney, such as urea, uric acid, creatinin, and various other end products of protein metabolism, have definite levels in the blood stream, and are excreted by normal kidneys under standard conditions in fairly definite amounts. When the kidney becomes damaged from various causes, it frequently has a lessened ability to excrete these waste products. They then increase in amount in the blood stream and, conversely, decrease in amount in the urine. Chemical studies of the blood reveal this increase in such instances, and studies of the urine reveal the decrease of these substances in the urine and give further accurate knowledge concerning the ability of the kidney to carry on its work.

The names of many Americans are included in the list of those who have worked out the various chemical tests that

are used in determining the presence and the amounts of these various substances. Van Slyke, L. J. Henderson, MacLean, Thomas Addis, Rowntree, Garritty, Wm. MacNider, L. H. Newburgh and Mosenthal are among a large group who have made important experimental and clinical observations along these lines.

The causes of the various forms of nephritis have long been a matter of study. Acute nephritis is very frequently the result of the excretion of bacteria by the kidney, particularly the poisons (toxins) of bacteria. The bacteria which cause acute infectious diseases, such as scarlet fever, typhoid fever, pneumonia, measles, mumps, influenza, etc., are especially prone by their toxins to damage the kidneys. The toxins liberated by the bacteria living in foci of infection in the body, such as abscesses at the roots of teeth, infected tonsils and sinuses, and carried by the blood stream to the kidneys for excretion, damage the filters (glomeruli) of the kidney to such an extent that nephritis may develop. When such foci of infection have persisted for a long time, the resulting acute kidney change frequently passes into subacute or chronic change. In such instances, the kidney structures that have already been destroyed cannot be replaced, but elimination of the causative factors may yet prevent further damage of the secreting structures. The great factor of safety that is present in the kidney in its ability to carry on work can be comprehended when it is recalled that there are in each kidney approximately four million individual secreting units, that is, glomeruli and associated tubules. It has been shown by Professor Richards and his associates that about 10 per cent of these tubules function at one time and that the remainder are in a resting state.

The question of the effect of particular kinds of foods upon the kidneys in causing kidney injury and in abetting injury in kidneys already damaged is one that has received much attention. Foods consist of three basic groups of substances, fats,

sugars (carbohydrates) and proteins. Proteins are present in greatest percentage in meats, cereals, bread eggs, and legumes. The end stages of protein digestion and of the breakdown of protein materials making up the body cells themselves result in a complicated group of substances, including urea, uric acids and amino acids. These substance have an acid ash and impart an acid reaction to the urine.

Since the advent of blood chemistry, a third great function of the kidney has been established. This is, the neutrality regulation of the body fluids. The chemical reaction of the blood is maintained at a very definite level. The present scale used for determining this measurement is the hydrogen ion concentration method, the abbreviation for this term being pH. The pH of the blood on this scale is 7.3. The slightest variation on either side of this point is fraught with grave consequences. On the acid side, it leads to a condition known as acidosis, and on the alkaline side, it leads to a condition of alkalosis, or excessive alkalinity. There are buffer substances in the blood which tend to prevent disturbance of this delicate acid-base equilibrium. The kidney itself, by the excretion of excessive acid substances if present in the blood stream, or by the excretion of excessive alkaline substances if they are present in preponderance, maintains this balance.

In recent years the question has arisen whether a diet which is excessive in protein and which places in the blood stream the acid factors of protein metabolism and upon the kidney the work of excreting these acid waste products might not be a causative factor in producing changes in the walls of the vessels in the tufts or filters of the kidney, and therefore play a role in the development of chronic Bright's disease and high blood pressure. A great amount of work has been done in attempting to establish the facts regarding this very important question. Americans, particularly, are a nation of heavy protein eaters and seem particularly prone to



develop chronic Bright's disease and high blood pressure. The study of this question has extended to various nations of the earth, in attempting to determine whether certain groups of peoples who are not protein eaters show less kidney and blood vessel disturbance. These studies have been carried on in an experimental way, both with human beings and with various groups of animals. The writer has had rabbits and rats on various diets. The urines, blood chemistry and blood pressures of these animals have been followed for a period of two to three years. At the conclusion of these experiments the animals have been killed and their blood vessels and kidneys carefully studied microscopically to determine whether changes have resulted. Degenerative changes were found in the blood vessel walls and in the kidneys of the animals that were on high protein diets. Lewis Harry Newburgh (1883— ) and Sarah Clarkson at the University of Michigan, among others, have reached similar conclusions following feeding experiments with laboratory animals. N. R. Blatherwick and his associates have recently recorded the presence of a marked chronic nephritis in the kidneys of rats that were fed high protein diets. Before the feedings were begun one kidney was removed from each animal, thus throwing a greater load upon the remaining kidney. There are, however, an equally large number of negative reports in this field in which high protein diets have been fed to various kinds of experimental animals. A critical study of some of these latter feeding experiments demonstrates that some were of too short a duration to expect kidney change. In others, however, this objection cannot be raised. In summary of this situation from the data at hand, final conclusions are not warranted. Further studies are necessary.

Human beings have likewise been used as subjects in experiments of this kind. Stefansson (1879— ), the explorer, only recently placed himself on a continuous meat diet for a year to determine whether

any evidence of altered function on the part of the kidney would result. The results of this and similar experiments are contradictory. In the instance of Stefansson, no evidence of injury or of disturbed function of the kidneys was detected. Newburgh and his co-workers criticized the diet that Stefansson was on, noting that 80 per cent of its energy was in the form of fat and that, in fact, only 100 to 140 gm. of protein were eaten daily. They contended that the protein content of this diet differed but little from that eaten habitually by great numbers of Americans, and that one would not expect to find evidence of kidney disease in so short a period of time as one year. They placed a normal individual, whose urine was albumin-free and contained less than the average number of casts found in normal men by the method of Thomas Addis, upon a diet in which one-third of the calories came from beef protein. The composition of this diet was, protein 338 gm., fat 271 gm., carbohydrate 96 gm. The total calories of this diet were 4177. After living for six months on this diet, he developed an albuminuria and a twenty-fold increase in the number of casts in his urine. This would seem to negate the evidence of the Stefansson experiment and to show that a high protein diet can harm the kidneys of man. As a further proof of this point, one can cite a nomad tribe in Russia that subsists largely on a meat diet and two-thirds of whose male members die of chronic Bright's disease or of a stroke due to degenerative changes in the blood vessel walls and to the accompanying high blood pressure. In summary of the data that have been presented on whether high protein diets in man are responsible for kidney injury, conclusions cannot yet be fairly drawn. Many believe that high protein diets do cause kidney damage. An even larger number believe the contrary. A great deal of work remains to be done to answer this question.

The present-day conception of the broad term nephritis is the result of the studies

of a large group of pathologists working in this country and abroad and of a number of clinicians who have classified the symptoms and the related laboratory findings that occur when these changes exist in the kidneys of a patient. Such a classification has recently been emphasized by Thomas Addis and Jean Oliver, and is as follows:<sup>27</sup>

#### I. Hemorrhagic Bright's Disease.

In this group there is injury to the kidney filters, the result of infection with some form of streptococcus. These patients have blood in the urine, develop a dropsy and a moderate increase in blood pressure.

#### II. Degenerative Bright's Disease.

In this group there is evidence of degenerative changes in the tubules of the kidney. The causes of this group are very diversified, including the changes which take place in eclampsia, various infections, and poisoning with the heavy metals, as mercury and uranium.

#### III. Arteriosclerotic Bright's Disease.

Diseases of the blood vessels of the kidney. This group is very prevalent. To understand it thoroughly, we must know the causes of hardening of the arteries. At present, we know very little of these causes.

### BIBLIOGRAPHY

1. A Historical Retrospect on Expectation of Life. *Statistical Bull. Metropol. Life Ins. Co.*, 8: 2, 1927.
2. Quoted by Oertel: The Anatomic and Histological Processes of Bright's Disease. Phila., Saunders, 1910, p. 4.
3. AVICENNA. De significantibus coloris urinae. Apud Juntas, Tom II, Fen II, Doctrina 3.
4. MORGAGNI, B. De sedibus et causis morborum per anatomen indagatis. Epist. XXXVIII, XL and XLII.
5. COTUNII. De ischiade nervosa commentarius. Vienne, 1770, p. 24.
6. Diabetes Mellitus. In Rollo. London 1798 vi. Cruikshank.
7. Observations on dropsy which succeeds scarlet fever. *Trans. Soc. Improvement Med. & Chirurg. Knowl. Lond.*, 3: 194-240, 1812.
8. BRIGHT, R. Reports of Medical Cases. I, 1827; II, 1831.
9. CHRISTISON. Observations on the variety of dropsy which depends upon diseased kidneys. *Edinburgh M. & S. J.*, 32: 315, 1829.
10. GRAVES, R. *Dublin J. Med. Sciences*, p. 16, 1833.
11. RAYER. *Traité des maladies des reins*. Paris, 1840.
12. SOLON. De l'albuminurie ou hydropsie causée par une maladie des reins. Paris, 1838.
13. BECQUEREL. Semeiotique des urines, ou traité des alterations de l'urine dans les maladies, etc. Paris, 1841.
14. HENLE, J. *Ztschr. f. rat. Med.*, 1: 67, 1841.
15. TOYNBEE. *Med.-Chir. Trans.* 29: 318.
16. VIRCHOW, R. Über parenchymatöse Entzündung. *Virchows Archiv.*, 4: 261, 1852.
17. KLEBS. *Lehrbuch der pathologischen Anatomie*. 1876, 1: 144.
18. BOWMAN. *Phil. Trans. Roy. Soc.*, 1: 57, 1842.
19. LUDWIG. *Lehrbuch der Physiologie*. Ed. 2, 1861, 2: 378.
20. DEZEINIERIS. *Dictionnaire historique*, Vol. II, p. 444. DAREMBERG. Exposition des connaissances de Galien sur l'anatomie pathologique et la pathologie du systems nerveux. Thesis 1841, pp. 13 & 80.
21. SIMON, G. Observations on Man and Animal Experiments on Changes in the Heart and Kidney as a Result of the Absence of One Kidney: *Chirurgie der Nieren*. 1871, pp. 63-89.
22. CUSHNY. *The Secretion of Urine*. London, 1917.
23. RIBBERT. *Virchows Archiv.*, 90: 169, 1883.
24. HEIDENHAIN. In Hermann's *Handbuch der Physiologie*. 1883, 5: 279.
25. RICHARDS. *A. J. M. Sc.*, 13: 1, 1922.
26. BIETER and HIRSCHFELDER. *Am. J. Physiol.*, 18: 326, 1924.
27. ADDIS, T., and OLIVER, J. The Renal Lesion in Bright's Disease. N. Y., Hoeber, 1931.



## BOOK REVIEWS

UNITED STATES ARMY X-RAY MANUAL. Ed. 2. Rewritten and edited by Lt. Col. H. C. Pillsbury, M. C., U. S. A. N. Y., Paul B. Hoeber, Inc., 1932.

This very popular work appeared during the World War as the cooperative work of various men and was intended to cover the problems of war service. Since then times have changed and, today, the radiologists of the Army have the same problems as their colleagues in civil life. The second edition has been prepared to meet these changed conditions.

The part on physics has been rearranged and permits easier reference. New types of apparatus and appliances have been added to the original text. Technique has been combined in one section rather than distributed throughout the book. Exposure tables are furnished. Those parts on interpretation have been enlarged and made modern. The illustrations have been added to, many of these being borrowed from "The Annals of Roentgenology." Therapy has been omitted.

The chapters comprise: X-ray Physics, Dangers and Protection, Laboratory Experiments, Fluoroscopy, Technique, Field Unit, Localization, Bones and Joints, Sinuses, Mastoids and Brain, Teeth and Maxillae, Thoracic Viscera, Urinary Tract, Gastrointestinal Tract. There is an ample Index. The illustrations number 228.

A pithy, comprehensive work, minus all unessentials. A work that will prove of inestimable value to all who do work in this broad field.

RADIOLOGICAL STUDY OF THE PARANASAL SINUSES AND MASTOIDS. By Amedee Granger, K.C.B., K.C.I., M.D., F.A.C.R. Phila., Lea & Febiger, 1932.

This is a small volume with 113 illustrations which show fairly well what the author is describing.

In the section on Paranasal Sinuses, attention has been centered on the sphenoids rather than on a detailed description of all of the sinuses but the author's description of the detection of sphenoiditis is carefully brought out in the section on mastoids. The

description of mastoids in children is complete and clearly defined. There is considerable description of the change of the Arcelin position made in the author's special way.

The illustrations, while, of course, lacking the detail of the original films, are very comprehensive. All in all, the book is a contribution to the roentgen diagnosis in otolaryngology and although the author perhaps overemphasizes his own methods, this work may be considered an added link between the surgeon and the roentgenologist.

SURGICAL PATHOLOGY OF PROSTATIC OBSTRUCTION. By Alexander Randall, M.A., M.D. Balt., Williams & Wilkins Co., 1931.

In reviewing so superb a monograph as this, it is difficult to decide which of its features is most praiseworthy and impossible to find language for its just applause. Surely it is an inspired opus, if there ever was one in medical literature, and represents ten years of the most exacting labors on the part of the author and his associates.

The bladder and prostate were examined in 1218 autopsies on males at the Philadelphia General Hospital. Among these, 312 instances of gross prostatic pathology were encountered, and the specimens were used, together with the case histories, to produce this treatise. The outcome is an atlas and a text which, it is stoutly believed, will enjoy one of the highest places of authority for many years to come.

The book supplies a very serious need in urological literature, because Watson's excellent atlas, published in 1888, appeared before the day of prostatectomy, and the works of Tandler and Zuckerkandl, Motz and Pearnau, Socin and Bruckhardt, and Lowsley, masterful and commendable as they were, were limited to considerations of benign hypertrophy only. The purpose of this monograph is four-fold: an analysis (based on this autopsy material) of four frequent lesions of surgical importance—hypertrophy, median bar, carcinoma and abscess; a description of the gross pathology; a discussion of the surgical handling of these conditions; and an exact photographic presentation of the lesions.

The tables present a striking picture of the increasing incidence of benign hypertrophy—

20 per cent in the fifties and an additional 10 per cent for each decade thereafter. These hypertrophies are classified as bilateral lobe, posterior commissural, and subcervical lobe involvement, and with various combinations of the three.

The anatomical, pathological, and surgical distinction between commissural and subcervical hypertrophy is made so clear by Randall's words and depicted so perfectly by the photographs that many a reader will here for the first time and for all time be set straight on this point.

As to the median bar, one gains here also the clearest sort of conception of this lesion "that has travelled the world over under various other descriptive terms and titles." The author is convinced (and convinces the reader) that "all true fibrous bars are fundamentally inflammatory in their origin and represent the end results of . . . chronic prostatitis." The one pathognomonic feature of bar formation he considers to be the "finding of the verumontanum drawn up to a point directly under the breast of the bar." The incidence of true bars in this series of prostatic obstructions was 4.6 per cent.

Two surgical lessons, somewhat at variance with the usual teaching, are drawn from the study of the 17 cases of prostatic cancer. The first is that the malignant process may arise in or involve any part of the prostate. The second is that the growth may, in certain cases, remain intracapsular.

Mr. Gosner, the official photographer of the Philadelphia General Hospital, photographed the specimens under water, exactly on their true scale, and has displayed in the rare perfection of these reproductions an art that provokes our very highest admiration.

IMHOTEP TO HARVEY. BACKGROUNDS OF MEDICAL HISTORY. By C. N. B. Camac, M.D. Foreword by Henry Fairfield Osborn, SC.D., LL.D. N. Y., Paul B. Hoeber, Inc., 1931.

About twenty-two years ago, when interest in medical history was relatively unawakened in America, Doctor Camac supplied a very important and most creditable work in his "Epoch-Making Contributions to Medicine and Surgery." In his present book he goes behind the scenes of those Epoch-Making Contributions and does some extensive explor-

ing into the territories and times whence they came. His explorations have been highly fruitful, for they have enabled him to give a very unique version of medical history, and one that shows the skilful handling and broad understanding that we can expect only from one who possesses a masterful knowledge of this subject.

Here he portrays the environments in which the scientific inquirers lived and labored, and thus allows the reader to see and feel many of the obstacles, struggles, aspirations and complex influences that played lively parts in the careers and discoveries of the great pioneers of medical and allied sciences.

In a scholarly foreword, Henry Fairfield Osborn calls attention to the repeated retardations that were suffered from such influences as magic and tradition, and the repeated appearance (as though to offset such obstacles) of some strong man "animated by scientific and humanitarian impulses, by the divine union of science and sentiment . . . to place the art of healing . . . among the highest of human achievements."

In "The Evolution of Inquiry" Camac shows the intellectual atmospheres, the viewpoints and the circumstances under which these strong men lived and worked. He contrasts such scientifically salubrious periods as the Hellenic and Renaissance with the long benighted epochs, and compares the receptions given to discoveries at such periods as those of Copernicus, Newton, Vesalius and Harvey. Here he points out the enormous retardation that results from the two great human failings: erroneous theorizing and false observations.

Among the strong men, Camac starts with the Egyptian, Imhotep (about 3000 B.C., engineer, statesman, physician) who was deified after death by the Egyptians as Asclepios was by the Greeks, and whom Camac considers the only conspicuously worthy oriental inquirer before the Greeks.

In "Greek and Greco-Roman Medicine" we are introduced to the area of Attica, about half the size of Rhode Island, but from which came the scientific thought that was to serve the whole world as a model, even to the present. Here was the beginning of rational medicine and pure science and here worked the three Authorities who were to dominate thought and practice for many centuries: Hippocrates, who introduced observation, hu-

man interest, and ethics; Aristotle, pupil of Plato and tutor of Alexander the Great, who gave us logic; and Galen, the last great figure in Greek medicine, who, though he showed that arteries and veins contained blood only, "showed" also many great fallacies that were unfortunately perpetuated by the weight of his authority.

The principal causes of the long period of scientific retrogression in the Middle Ages are considered to be: the Roman conquest; the change from polytheism to monotheism, resulting in the destruction of pagan literature; the barbarian invasions. But the Greek influence was kept alive by six agencies: the schools at Alexandria, Byzantium, Edessa, the Arabian schools, the monastic schools in Europe, and Salerno—the first of the Christian schools.

Arabian or Mohammedan Medicine, "the one ray of scientific light in the Dark Ages" has not been stressed by historians until recently, possibly because of the feeling, religious and political, against the Mohammedans who threatened Europe until the 16th century. Camac dwells at length on this people's search in classical literature for knowledge, and gives a splendid picture of the "Arabian Renaissance" when hospitals and medical schools flourished at Bagdad, Cairo, Damascus and Cordova, and when the Caliphs were giving every support to scientific advancement and to the large number of translators, notably the elder and younger Mesuës and the Nestorian Christian Arab, Johannitus.

In the pre-Renaissance period, in addition to such far-reaching influences as the discovery of printing and the siege of Constantinople there came the establishment of great universities (Paris, Bologna, Oxford, Montpellier, Cambridge, Padua—where Harvey graduated 1602) and the appearance of four great reconcilers of philosophy, theology and Hellenic science: Albertus Magnus, Roger Bacon, St. Thomas Aquinas, and Peter of Abano.

Why did pathology and physiology lag so far behind other sciences, such as physics and astronomy, during the Renaissance? Camac's very reasonable answer is that physics and astronomy were based upon mathematics, which was unrestricted by religious and other forms of intolerance while the medical sciences were based on anatomy, which was restricted

and retarded at many points. In this connection it is noteworthy that Vesalius's "*Fabrica Corporis Humani*," the first overthrowing of Galen's authority, appeared in the same year, 1543, as Copernicus's "*Revolutionibus*." But to such restricting agencies during the medieval and Renaissance periods, as excommunication, the Inquisition, and the Index Librorum Prohibitorum, there was a profound reaction, a reaction leading to actual experiments in physiology and flowering in Harvey's monumental work.

This reviewer is tempted to mention some of the author's treatment and absorbing analysis of events in the 17th century, but space does not permit.

One of the most valuable features of the book is to be found in the appendix, which includes excellent reference maps and tables and numerous quotations from many of the finest classics in the history of general science and medicine.

PROHIBITING MINDS. By Stewart Paton, M.D. N. Y., Paul B. Hoeber, Inc., 1932.

We do not know how to describe this book except to say it is a classic. In this age of prohibition this work comes as a welcome relief. Scientifically, and in language that is well nigh inspired, the author lays bare the causes of our present-day mania to prevent the other fellow from following his natural, God-given bent.

After the Preface, the Chapter headings are: Civilization-shock, Remedies, Educating the Intellectuals, and References. There are an Index of Personal Names and an Index of Subjects.

It is beyond our pen to outline the field the author covers. A sentence here and there might whet one's appetite to read the whole. We read: "Today all over the world people squander their supplies of nervous energy. They travel so fast that they do not have time to balance their emotional and mental budgets . . . They do not have leisure in which to learn to steer and control the human machine . . . Neurotics naively confess that they think history is bunk, and attempt to conceal their fears of the past by pretentiously announcing that they are the forward-looking representatives of the human race . . . Prophesying disaster should not be encouraged . . . What we sorely need at present are constructive

suggestions that will help us to live . . . At present the chief occupations of a great many people are prophesying and prohibiting . . . At present we are prohibiting mad."

An interesting and an absorbing book. Would that the majority of the people would read and digest it. But at least physicians should read it and, as a result, light the way.

COURTS AND DOCTORS. Lloyd Paul Stryker, M.D. N. Y., The Macmillan Co., 1932.

Lloyd Paul Stryker, not so long ago, was general counsel for many years for the Medical Society of the State of New York, and had charge of the legal policy of the Society and the defense of its members who were sued for malpractice. We have heard hundreds of expressions of admiration for the skillful and thorough manner in which he defended the members who were sued in the courts. His powers became almost a saga. And so this little book is more than welcome. It makes delightful reading. We picked it up merely intending to glance through its pages: we read it carefully from cover to cover. It contains simply told facts that should be known by every practicing physician. Such knowledge is necessary to his protection and may save him an endless waste of time, much worry, and possibly a considerable sum of money.

The book is divided into seven parts. Part 1 deals with The Practice of Medicine; Part 2, The Relationship of Patient and Physician; Part 3, The Action for Malpractice; Part 4, Defense to Actions for Malpractice; Part 5, Expert Testimony; Part 6, The Doctor on the Witness Stand; Part 7, The Doctor and the Criminal Law.

The preface is written by Charles Gordon Heyd, President-Elect of the Medical Society of the State of New York.

At the beginning of Chapter 10 we read what seemed almost a prophecy, considering events that have transpired about the time this review is written. The author says: "'Every human being,' said Chief Judge Cardozo of the New York Court of Appeals, 'has a right to determine what shall be done with his own body . . .'" In his usual terse and compact style this great judge, the most profound and philosophical, and with the possible exception of Justice Holmes, the most celebrated jurist in America

. . . " And it comes to pass that Judge Cardozo succeeds Justice Holmes in the United States Supreme Court.

A splendid book. We mean to reread it three or four more times. It should be in every physician's library and become a part of his medical equipment.

GRENZEN DES NORMALEN UND ANFÄNGE DES PATHOLOGISCHEN IM RÖNTGENBILD (Borderline of Normal and Beginning Pathology in Roentgenograms). By Alban Köhler. Ed. 6, revised. Leipzig, Georg Thieme, 1931.

If the reviewer could possess only one book on roentgenology, his choice would unquestionably be the volume before him. It is self-evident that roentgenological interpretations cannot be made without adequate familiarity with the normal. Daily contact with large amounts of roentgen material teach us how often accessory bones are diagnosed as fractures, diverticula as ulcer craters and even carcinoma, normal lung markings as evidence of pleurisy or tuberculosis, exaggerated bony excrescences at the point of insertion of the muscles as exostoses, and other numerous erroneous diagnoses. Knowledge of the normal and the anomalies is a pre-requisite for dependable roentgen interpretation, where the most difficult field relates to the borderline pathological changes. The book should prove especially valuable as a guide in medico-legal testimony.

The author in 1910 began the accumulation of data relating to the normal and beginning pathological changes, to which he has from edition to edition made liberal additions. The latest production is brimful of information, familiarity with all of which is too much to expect of any one and, for that reason the book should be on the desk of every physician who attempts to translate roentgen findings. It is fortunate that the fifth edition of this book is available in English; it is to be hoped that the sixth edition will also find its way into English print.

DIE RÖNTGENDIAGNOSTIK DES VERDAUUNGSKANALS EINSCHLIESSLICH DER LEBER UND DER GALLENWEGE (Roentgen Diagnosis of the Digestive Tract, including the

Liver and the Biliary Tract). By Privatdozent Dr. H. V. Albrecht. Introduction by Professor F. Volhard. Leipzig, Georg Thieme, 1931.

Up to the minute in every respect, this volume at once commends itself as a modern textbook on the x-ray examination of the digestive organs and of the biliary system. The illustrations are superb, leaving little to be desired. Many explanatory drawings supplement the text and the roentgenograms. The striking feature of the work is the adoption throughout of the newer methods of study by visualizing the gastrointestinal mucosa with relatively small quantities of mucilaginous mixture rather than by complete filling of the various organs with opaque material. Some of our readers may not have learned that an entirely new chapter has been written into the x-ray study of gastrointestinal diseases by seeking to bring out details of the mucosa of the esophagus, stomach and intestine. Chronic gastritis, which we thought was a *passé* subject, has been revived and elaborated since the device of methods for demonstrating the gastric rugae.

This book should be of value to the physician as well as the surgeon, for much space is given to the consideration of functional disorders as seen on the screen and roentgen film. It is refreshing to find a German work with such recognition of American contributions to gastrointestinal roentgenology. The chapter on the biliary tract is an adequate presentation of this newer American contribution.

DIE AVERTINNARKOSE IN DER CHIRURGIE. By W. Anschütz, K. Specht, and Fr. Thiemann. Berlin, Springer, 1930.

This first textbook on tribromethanol narcosis, based on the authors' own experiences and the literature until 1930, was published as a paper in Volume 23 of the "Ergebnisse der Chirurgie und Orthopädie." Published as a monograph of 200 pages, it was only too soon out of print. The claims concerning the efficacy of proprietaries in the field of pharmacology, especially as experimentally controlled by the manufacturers, have often resulted in many exaggerations. Anschütz and his co-workers have successfully tried to evaluate claims of the earlier investigators sponsored by the producers

in the manufacturers' catalogue. After describing in detail in the introductory chapter the chemistry and pharmacology of avertin, its pre-medication, they discuss dosage, the usual supplementation, the course of the anesthesia, accidents, mortality statistics, and its contraindications.

In spite of rapid technical development in avertin anesthesia since the printing of the monograph, the booklet is not antiquated and may be still used as a reference book for experimental and clinical work, as it is stimulating and reliably instructive. Of course, the chapters on pre-medication and on satisfactory supplementation with local anesthesia, the antidotes, as coramin, the statistics, etc. would have to be revised to correspond with the later hundred or more publications in America and abroad.

The unique action of tribromethanol in the treatment of tetanus, its astounding quieting effect on patients on whom thyroidectomies are to be done for thyrotoxicosis, the small amount of supplemental inhalation narcosis required, the very few contraindications to its use, support the authors' prophecy that we have in avertin a valuable addition to the list of anesthetics. This monograph besides is of historical value as the first comprehensive criticism of this new rectal narcosis and as the first textbook on tribromethanol anesthesia.

EINE STUDIE DES NIERENTUBERCULOSEMATERIALS AUS DER LUNDER CHIRURGISHEN KLINIK DER JAHRE 1901 BIS EINSCHL. 1923. By Robert Ivarsson. Stockholm, P. A. Norstedt and Söner, 1931.

This paper-bound treatise of 138 pages, which forms Vol. 68, No. 18 of *Acta Chirurgica Scandinavica*, is an exhaustive analysis of data collected during the study of cases of renal tuberculosis at the Surgical Clinic in Lund between 1901 and 1923.

It is a most respectable addition to the literature on this subject and presents very completely the many points in the diagnostic problem and the probabilities as to the trends of events on the side of prognosis.

Of 155 patients who were nephrectomized, 101 are still living, 86 of whom are considered cured. Of the 54 who died, 21 died within the first year after operation. Among 36 unoperated patients, 28 died in the first year and 4 are healed in a clinical sense.

# PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D.

AND

LOYAL DAVIS, M.D.

## FOURTH INSTALLMENT

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## CHAPTER XV

### PATHOLOGY OF PERIPHERAL NERVE LESIONS

In civil life injuries to nerves are usually simple in origin and relatively uncomplicated in nature as compared to the injuries sustained in warfare. The ulnar or median nerves may be cut by a puncture wound at the wrist and the superficial injury to the skin may be entirely healed before the nerve lesion is recognized. Traction or contusion may produce nerve injuries in civil life, which by the very apparent innocence of the trauma, may cause the nerve damage to be overlooked completely.

In warfare the passage of a machine gun bullet may leave a wound in the superficial tissues which heals quickly. On the other hand, a shell wound may be accompanied by a large loss of tissue which includes a long segment of the nerve and by the fracture of bones. Healing may be complicated by serious infection and the formation of a massive scar. In war it may be natural that a nerve lesion is overlooked due to the immediate exigencies of the situation in which hemorrhage, complicated fractures and infection furnish problems of vital importance.

Under both conditions, however, the early recognition of a nerve injury as the part of a pathologic picture is of serious importance. To suture a wound of the wrist in complete ignorance that the median nerve may be divided or to reduce a dislocation of the shoulder joint without realizing that the brachial plexus may be injured is a mistake extremely unfortunate for the patient.

In the pathological picture presented by a peripheral nerve injury it is necessary to consider not only the associated lesions in the soft tissues, bones, tendons and blood vessels; the presence or absence of possible infection, but also the changes which may ultimately result from the nerve injury, such as the atrophy of muscles, fibrotic changes in joints and the trophic disturbances of the skin.

## NERVE PATHOLOGY

A complete anatomical section of a peripheral nerve may result from incised, lacerated or puncture wounds in the soft tissues by bullets, shell fragments or by splinters of bone. The importance of these different etiological factors lies in the fact that the actual loss of nerve tissue varies considerably and in that the presence of infection is more likely in the wounds accompanied by large loss of tissue.

When a nerve has been completely divided by any of the possible methods of injury, the central and distal ends become separated for a distance depending upon the loss of tissue and the surrounding scar tissue formation. The latter may be so pronounced that the nerve is displaced from its normal relations. Immediately the formation of scar tissue begins between the severed ends (Fig. 79). We have already discussed the attempts on the part of the axons of the central end to regenerate. As they grow downward they meet this buttress of densely growing connective tissue. These axons could have entered this connective tissue only when it was young, cellular and vascular. But at that time the axons are in the stage of cellulipetal degeneration and their growth is therefore not *pari passu* with the connective tissue. By the time the down-growth of axons reaches the gap there is a firm mass of dense connective tissue instead of a loose, cellular, vascular tissue. The axons are therefore turned back upon themselves in a twisting, spiral, coiling mass. As a result of this proliferation of connective tissue a bulb forms upon the central end which is firm, circumscribed, more or less rounded and greyish-white in appearance. This bulb cuts with a gritty sensation and macroscopically one may see numerous fine, grey translucent dots and lines (Fig. 80). Occasionally one may see larger grey or greyish-pink translucent areas. The grey color is due to young nerve fibrils surrounded by a stroma of connective tissue fibers. When this stroma is cellular and vascular a pink color is added to the grey. The younger the bulb the more

translucent, succulent and greyish-pink is its appearance. The presence of regenerating axons in the mass of connective tissue makes the bulb on the central nerve end sensitive and

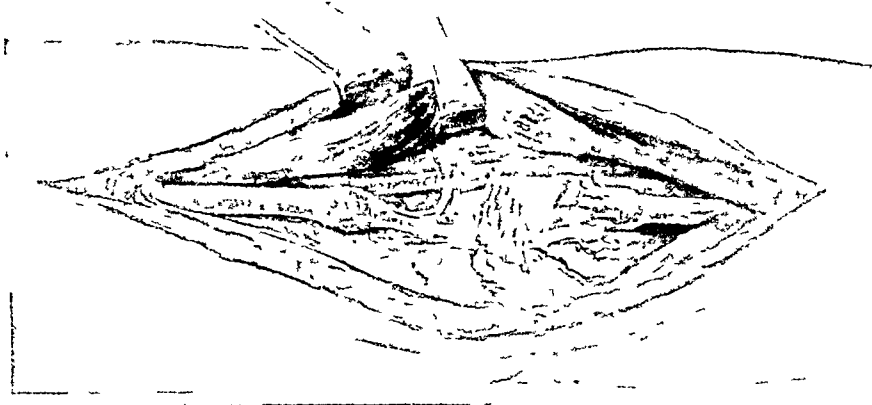
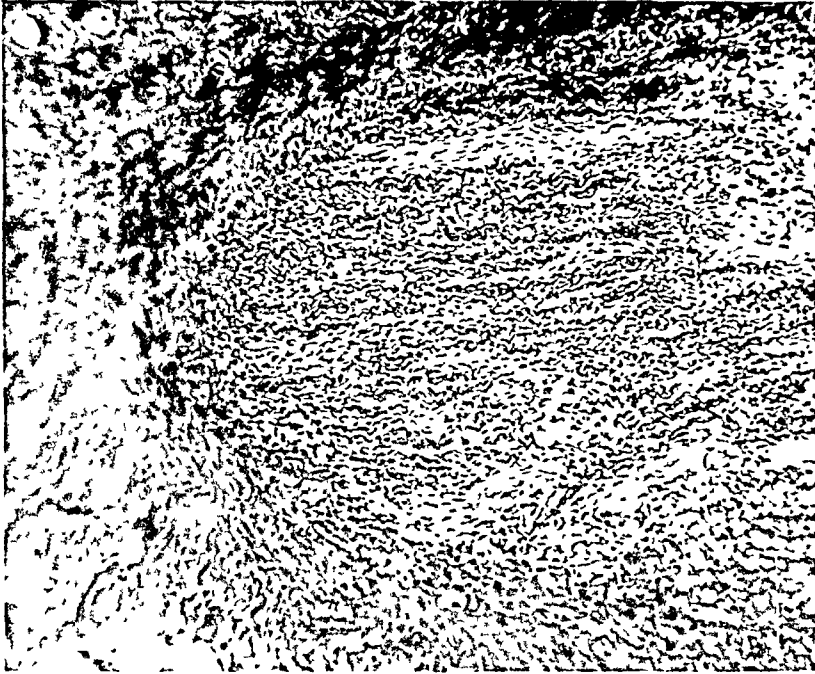


FIG. 79. Scar tissue surrounding ends of divided median nerve. Note bulbous neuroma on central end of nerve trunk.

painful upon palpation. The varying density produced by the growth and contraction of this scar tissue gives corresponding patterns of the nerve fibers in it.

The end of the distal segment is enlarged also by the formation of connective tissue. The size of the bulb is usually smaller than that found on the central segment. It may be round or elongated in shape. The bulb consists entirely of connective tissue fibers since there are no regenerating axons present in the distal segment. This bulb is grey in color and firm but not painful to palpation. Both the bulbs on the distal and central segments of the nerve are usually found firmly bound down to the surrounding muscle and scar tissue. Muscle fibers occasionally may be found between the connective tissue fibers in the distal bulb which completely caps the cut end of the distal segment.

A nerve may be sectioned incompletely at the time of injury. The most common type of such a lesion appears macroscopically as though a notch had been cut into the side



A



B

FIG. 80. Microscopic appearance of (A) central neuroma and (B) distal neuroma.

[[144]]

of the nerve trunk (Fig. 81). The nerve above and below the notch becomes bulbous and the microscopic picture is similar to that seen in the central and distal bulbs of a completely

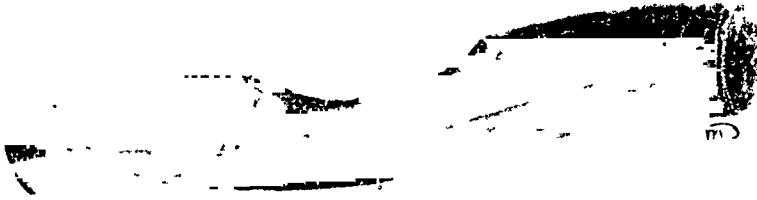


FIG. 81. Incomplete lesion of nerve trunk with production of notch in side of nerve.

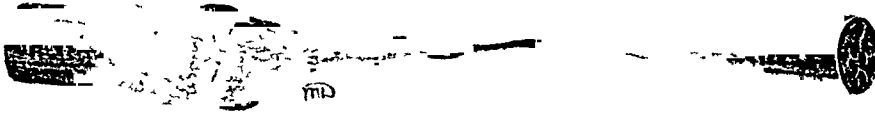


FIG. 82. Union of neuromas on central and distal ends of divided nerve by scar tissue.



FIG. 83. Lateral neuroma.

sectioned nerve. Occasionally the bulbs formed after a complete severance of the nerve may be joined by a considerable band of tissue which apparently establishes continuity (Fig. 82). Microscopic examination will show that this thin, long, ragged bridge consists entirely of fibrous tissue. A connective tissue nodule may be formed on the lateral aspect of a nerve as the result of a trifling injury which may or may not have produced a small lateral notch. The microscopic picture is that just described in miniature (Fig. 83).

The clinical symptoms produced by complete or incomplete anatomical section of a peripheral nerve may be reproduced identically by pathological processes which cause a physi-



FIG. 84 Compression of nerve trunk by surrounding scar tissue.

ological interruption in the transmission of the nerve impulse. Among the most common causes of such a physiological block is compression of the nerve by scar tissue, by callus formation in a uniting fracture, aneurysms, rudimentary ribs and by adhesion of the nerve to neighboring structures. Extensive injury to the surrounding soft tissues accompanied by an infection may produce a mass of dense scar tissue which surrounds the uninjured nerve, compresses it and often pulls it far away from its normal relations (Fig. 84). The contracting scar tissue may spread over a large area or it may appear as a narrow encircling band. The nerve may appear smooth or rough but always grey and firm. Cross section shows a homogeneous grey fibrous tissue according to Cone, but occasionally, translucent, fine, pin-point areas are seen which indicate the presence of young nerve fibers. Cone has described a type of tissue to be seen about nerves, usually near the injury but often at some distance away. It is translucent, circumscribed and is distributed irregularly. This has been termed "nerve callus" and is exactly like a nerve bulb.

As a fracture unites, a considerable amount of callus is usually laid down, particularly if the fracture is comminuted. This mass of callus may lie beneath a nerve or, commonly, may completely surround it (Figs. 85 and 86). A fracture of the olecranon process of the ulna or of the inner condyle of the

humerus may be accompanied by callus formation which compresses the ulnar nerve sufficiently to produce a complete physiological interruption. The radial nerve may be surrounded



FIG. 85. Compression of nerve trunk by bony callus formation.



FIG. 86. Narrow band of scar tissue encircling nerve trunk.

entirely by callus formed about a fracture through the middle third of the humerus where the nerve lies closely apposed to the bone.

Rudimentary costal processes arising from the seventh cervical vertebra may produce an irritative lesion of the eighth cervical or first thoracic roots as they join the brachial plexus. This lesion may progress to produce a destructive lesion with all of the symptoms of a complete physiologic interruption of the nerve fibers involved. Such rudimentary costal processes may be of several types. They may be fused with the transverse process of the seventh cervical vertebra and continued forward as a fibrous band attached to the first thoracic rib behind the scalene tubercle. They may appear as a short rib articulated



to the seventh cervical vertebra by costo-central and costo-transverse joints with a fibrous band which is attached to the first rib. A rudimentary first thoracic rib may be present with



FIG. 87. Fusiform neuroma of nerve trunk.

an anterior fibrous attachment to the sternum. Wood-Jones believes that the development of ribs in the cervical region is arrested at the point where the nerves, taking an oblique course to reach the extremity, cross a primitive mesoblastic costal element. If a large part of the second thoracic root goes to form the brachial plexus, the first thoracic rib may be deficient and may be continued to the sternum as a fibrous cord or it may be fused with the second rib. Such a brachial plexus is said to be post-fixed. A pre-fixed plexus is associated with an abnormal development of the costal anlage of the seventh cervical vertebra. Adson has called attention to the frequency with which the anterior scalenus muscle is tightly stretched over the nerve roots which lie on top of the rudimentary rib. Thus in addition to the constant movement of the nerve trunk over the rudimentary rib, it is compressed from above by the muscle.

Aneurysmal dilatation of vessels, particularly the subclavian artery, also may produce compression of a nerve trunk with consequent impairment of its physiological function.

A symmetrical elliptical bulb may be found in the continuity of a nerve and its presence denotes evidence of an internal injury to the nerve trunk (Fig. 87). These bulbs are

edematous, greyish-pink in color and show white lines traversing their length. Numerous fine capillaries are present and proliferating young nerve fibers are present. The microscopic



FIG. 88. Stab wound of nerve trunk.



FIG. 89 Perforating wound of nerve trunk.

picture is similar to that seen in "nerve callus" except that this tissue is more edematous. Often these bulbs may be discolored in appearance due to a deposit of granular blood pigment about the newly formed connective tissue, capillaries and nerve fibers (Figs. 88, 89).

Marie and Foix have drawn attention to a condition designated as an interstitial neuritis. There are isolated areas of inflammation with retrograde and descending changes in the axis cylinders, myelin and neurilemma sheaths. Marked endarteritis of the medium and small-sized blood vessels may be present.

#### ASSOCIATED PATHOLOGY

In addition to the pathology which directly involves the nerve trunk, there are important changes in other structures consecutive to and coincident with the nerve injury. The most

important of these are the striking objective changes which occur in the muscles innervated by the injured nerve. After a nerve lesion the tone of the muscle is entirely lost, its volume shrinks and, if unsupported, it stretches indefinitely. The muscle fibers become pale, shrunken, the striations disappear and the muscle comes to resemble non-striated muscle both in its histological appearance and physical characteristics. In neglected cases the muscles completely lose their contractility and ultimately degenerate into fibrous tissue and fat. There is a proliferation of connective tissue between the muscle fibers and an obliteration of the lymph spaces. Adhesions form which eventually prevent all freedom of movement. Langley and Kato have shown that a denervated muscle loses approximately 30 per cent of its original weight in the first two weeks after section of its nerve supply.

The pathological changes accompanying peripheral nerve lesions which are found in the joints may be due to immobilization of the extremity, fractures within or near the joint or to other changes in the joint itself due to causes which are difficult to determine. It is interesting to note that stiff, fibrotic or ankylosed joints are the rule following peripheral nerve injuries but they are quite rare in cases of anterior poliomyelitis. This is true in spite of the fact that in both instances a flaccid paralysis with muscular atrophy is present. The fact that the joints of the upper and lower extremities receive a supply from the peripheral nerve trunks may explain these changes, although little is known at present concerning the effect of a nerve lesion upon joint capsules, ligaments or aponeurosis.

In some instances synovial adhesions form, but the most pronounced pathological changes are to be seen in the infiltration and fibrotic contraction of the capsules and ligaments about the joint. The metacarpophalangeal and interphalangeal joints show striking changes which are usually more prominent on the dorsal surface. The opposite picture to a fixed and rigid joint may occur in a few instances due to the paralysis

of a muscle upon which the joint depends for its support. This is exemplified in the shoulder joint. Paralysis of the deltoid and dorsal muscles of the scapulae may allow the joint ligaments to become so lengthened that the head of the humerus drops away from the glenoid cavity. Such a condition is known as a flail joint.

Certain vasomotor, trophic and secretory disturbances which occur in patients with peripheral nerve lesions have been considered to be the inevitable result of the nerve lesion. However, an accumulated war experience showed that in such cases there was a vascular lesion in addition to the injured nerve. Meige and Bénisty have pointed out the necessity of suspecting a concomitant injury to a large vessel supplying the extremity. Particularly is this important when the surface of the skin of the hand or foot appears glossy, has a reddish-purple or blue-black color and is succulent. The fingers may have an edematous appearance at their tips and here too, the skin has a fine, smooth, glossy, purplish-red appearance. In other cases the skin may be dry and scaly, like that of ichthyosis. Under these scales it may be wrinkled and contracted. The finger tips are pointed and the paronychium is swollen.

Ulcerations of the skin are frequently present. They may be the result of a trifling excoriation; blisters form, burst and may suppurate. They occur at the ends of the fingers, the radial side of the index finger and the inner side of the hand. In the foot they are found at the ends of the toes. They have a red floor with thick indurated edges. They heal very slowly, with marked scars which deform the appearance of the finger.

The finger nails show longitudinal striations and their surface becomes more convex. They may be uneven, patchy and formed of two pieces, one of which is near the base and the other near the tip, joined by an irregular transverse ridge. It is not uncommon for a nail to be lost and to be replaced by a shapeless thick horny tissue.

The subcutaneous tissues of the extremity may show a hard, elastic infiltration which is quite unlike edema. Bénisty

has suggested that this may be due to a lesion of the lymphatic trunks. The hair of the skin grows more slowly and sweating of the extremity is absent.

While ulcerations of the skin, changes in its color and appearance, hypotrichosis, absence of sweating and nail changes may occur in uncomplicated lesions of the nerve trunks, they are more common and more pronounced in cases with a concomitant vessel injury.

There is a certain group of affections which is characterized by paralysis with contractures, simple contractures, and hypotonic flaccid paralysis without a lesion of the nerve trunk. They have been termed "physiopathic affections" by Meige and Bénisty and under this classification is placed the "congealed hand" to which attention was called first by Henry Meige. The symptoms of this group of disorders have been discussed.

The pathogenesis of these physiopathic affections has been discussed widely and as yet is not settled definitely. Babinski and Froment have assigned a very important rôle to the sympathetic system in view of the vasomotor and thermal disturbances which influence the muscles. They believe there is a vasoconstrictor spasm produced by a reflex irritation which originates in a peripheral lesion. Léri and Roger, while admitting that the majority of cases are functional, call attention to similar contractures in organic cases. They mention metal dust embedded in the muscle fibers as an etiologic factor. Further, they point out that the irritation may affect the nerve and not the muscle; and that contractures occur in muscles which are antagonistic to the paralyzed muscles. Guillain and Barré, state that ischemia must be taken into consideration in producing these contractures. Other authors believe that the prolonged immobilization of a limb, which may be necessary to treat a wound or fracture, contributes to the production of these symptoms.

Bénisty has summarized the pathogenesis of these disorders succinctly. She has grouped the lesions under four

pathogenic factors; first, painful neuritis; second, direct involvement of the muscles; third, involvement of the bones, fibrous tissue and tendons; and fourth, a slight wound accompanied by voluntary, prolonged immobilization of the extremity by the patient. In the first group the nerve lesion is slight and usually involves the median or ulnar in the forearm or at the wrist. It is followed by periarticular fibrosis, generalized atrophy and some decalcification of the bones. The second group calls attention to the fact that persistent contractures may be due to direct irritation of the muscle by a foreign body. Injuries of bones, muscles or tendons with suppuration may necessitate plaster-of-Paris or sling immobilization. The joints may become inflamed and there may be a general wasting of all of the tissues. Into the last group are placed the cases described as "congealed hand." Here, prolonged immobilization plays an important rôle in the pathological picture.

#### TUMORS OF THE PERIPHERAL NERVES

**NEUROMA:** Many tumors which occur upon the peripheral nerves have been classified loosely and inaccurately as neuromas. Only new growths upon peripheral nerves which have within their structure either nerve cells or nerve fibers may be classed properly as neuromas (Virchow). Perhaps the only pathological condition to which this term may be applied accurately is the amputation end bulb. As has already been stated, in these bulbs there are newly formed axons which course in a twisting, spiral, intertwined fashion in their attempts to regenerate following injury. Moreover, there is an hyperplasia of cells of the neurilemma and proliferation of endoneural connective tissue. It is doubtful, however, whether or not these end bulbs should be termed neuromas since they are not pathologic new growths but represent attempts at regeneration.

**NEUROFIBROMA:** Under this term, which is in common use clinically, may be grouped the tumors described by Bruns as

elephantiasis nervorum, as molluscum and secondary malignant neuroma. v. Recklinghausen first showed that multiple fibromas of the skin, fibroma molluscum and multiple neurofibroma had a common origin from the endoneurium and perineurium of peripheral nerves. It is by his name that the multiple occurrence of these tumors over the body is known today. It is believed that the occurrence of these multiple tumors is the result of a congenital predisposition to form connective tissue tumors of the nerves due to an irregular distribution and arrangement of the connective tissue elements of the nerves (Garrè, Ribbert).

Neurofibromas may occur singly or may be multiple upon any of the peripheral, cranial or sympathetic nerves. Upon the peripheral nerves, the tumors may surround the nerve trunk completely and form a distinct fusiform swelling or they may lie within a capsule within the nerve, this separating its funiculi. They may arise from the endoneurium but more commonly have their origin in the perineurium and rarely, if ever, in the epineurium. Aschoff has shown that they do not arise from the nerve fibers and that even after degeneration and disappearance of the nerve fibers, these tumors may occur. Microscopically, the tumors are scant in cells. The fibers are closely packed together and have a course parallel to the nerve fibers.

These tumors may undergo malignant degeneration and Garrè has emphasized the rapidity of growth and recurrence under such circumstances. Garrè gives 12 per cent as the frequency of occurrence of malignant change (Fig. 90).

**NEUROBLASTOMA:** Tumors of the peripheral nerves may arise from the cells of the neurilemma. These tumors have been described by various authors in isolated instances as gliomas of the peripheral nerves (Bertrand and Charrier). The tumor was first described by Verecay, and Stout has given recently an extensive and complete account of the neoplasm. Microscopically the tumor as described by Stout consists of "masses and strands of rather small, rounded cells, many of which showed mitoses, separated by trabeculae of connective tissue. Scattered

through the tumor cells at irregular intervals are many rosettes." Grossly the neuroblastomas resemble sarcomas and metastasize freely.

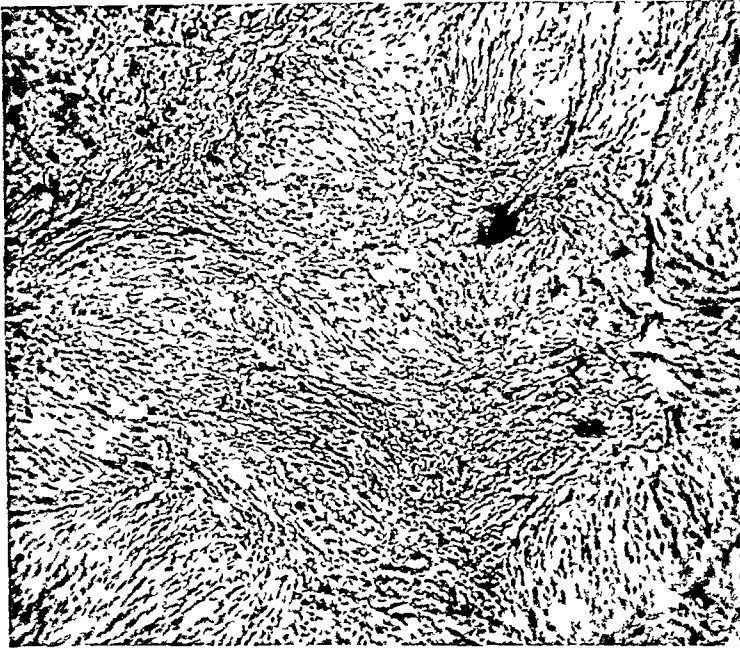


FIG. 90. Microscopic section of peripheral nerve tumor.

**NEUROSARCOMA:** Sarcomas may involve any of the peripheral nerve trunks and like the neurofibromas arise from the perineurium or endoneurium. They may occur as the fibrous, myxomatous or spindle-celled variety. Bloodgood has shown that like the neurofibromas, the nerve fibers are not part of the tumor mass. They may reach a very large size and if they metastasize do so to the lungs or pleura.

**GANGLION:** Duhs described a small tumor mass which occurred upon a branch of the ulnar nerve in the hand and which upon section contained a glassy, gelatinous material similar to that found within the ganglion which occurs upon tendons. Ries was able to collect only seven cases in the literature which indicates that it is of rare occurrence. Interestingly all of the patients were men, which Ries believes may be due to the greater exposure of men to physical injury.



## CHAPTER XVI

### HISTOPATHOLOGY OF NERVE DEGENERATION AND REGENERATION

The surgical treatment of injuries to peripheral nerves is dependent entirely upon a clear understanding of the histopathologic changes produced in the neuromuscular system by the complete anatomic or physiologic separation of a nerve fiber from its cell of origin. The results of innumerable experimental investigations in the laboratory and clinic upon this question have added overwhelming evidence in favor of the neuron doctrine. This theory holds that that part of a nerve fiber separated from its cell or origin will degenerate and that portion remaining attached will show attempts to regenerate. This briefly stated principle underlies the conception of all of the histopathologic changes encountered in the degeneration and regeneration of peripheral nerves.

The history of the experimental work upon peripheral nerves extends back to the eighteenth century when in 1787 Arnemann made the observation that the distal portion of a divided nerve lost its irritability and glistening white appearance. Cruikshank and Haighton, independently engaged in similar experiments upon the vagus nerve, reported identical results. They sectioned the vagus upon one side and after allowing the animal to recover, cut the opposite nerve and kept their animals alive. Previously, section of both nerves simultaneously produced death. Regardless of how accurate these experiments would be regarded now, nevertheless they served as an adequate stimulus for further studies. The response to the stimulus did not appear, however, for fifty years.

Beginning in 1839, with Nasse, there was a large group of contributions which dealt with the histologic changes present in the distal portion after separation from its cell of origin. In 1852, Waller clearly demonstrated these histologic degenerative phenomena in the distal nerve fragment. It is clear that

he regarded the cell of origin as the nutritive center for a nerve fiber and without it believed that regeneration was impossible. It was natural that Waller's views, which are in exact conformity to the neuron doctrine, met with opposition. Philippeaux and Vulpian believed that they found evidences of regeneration in the distal portion of a divided nerve although it had been left separated from the central end. Other investigators (Schiff, Wolberg, Erb) stated that though separated from the cell of origin no evidence of degeneration was found in the distal portion. According to this latter view, opposed to the neuron doctrine and to Waller's views, after apposing the two ends of a cut peripheral nerve it was necessary only for a distal axon to fuse with a central axon and for a new myelin sheath to be developed.

A series of investigations in the last decade of the nineteenth century stimulated interest in and focussed attention upon the problem of peripheral nerve repair. The results furnished evidence about equally divided in favor of and against the neuron doctrine. According to Büngner in the process of regeneration the nuclei of the neurilemma increased in number; protoplasm collected about them; longitudinal striations occurred in the protoplasm and finally these cells became fused into long bands. The striated protoplasm, he stated, differentiated into a new axon and the myelin was developed in the surrounding protoplasm. These "*Bandfasern*" have played an important rôle in the argument for the autogenous regeneration of nerve fibers. Their actual histologic significance will be seen later. Stroebe developed a new method for staining the axis cylinder and contrary to Büngner believed he could demonstrate a downward growth from the central end of a sectioned nerve. Huber used Stroebe's method and was able to obtain a clearer microscopic picture of the regenerative process than had ever been described. Howell and Huber confirmed the observation of Büngner regarding the presence of the protoplasmic bands in the distal segment but were unable to detect regenerating axons within them. They did describe,

however, the downgrowth of axons from the central segment, which, in some instances, entered these protoplasmic bands. Some of the axons ended abruptly with bulbous enlargements on their free ends. They regarded the "*Bandfasern*" as embryonic nerve fibers which they believed to be capable of receiving and conducting nerve impulses. They further stated that if the two ends of the divided nerve were not in apposition the regenerative process ended with the formation of Büngner's protoplasmic bands. However, if the ends were in apposition the bands of protoplasm in the central and distal segments united, myelin was formed within them and the axons grew down into them from the central segment. Soon after Ziegler, Galeotti and Levi, Kennedy and Wieting published the results of their work which tended to show that new axons developed *in situ* in the distal segment.

This was the state of affairs in 1903 and the lack of convincing experiments was due to the fact that no staining method was available which would clearly picture the process that took place at the site of union of the ends of a divided nerve. Bethe therefore attempted to show what would occur in an isolated distal segment of nerve. He believed the process would be simpler, easier to analyze and that the results could be used directly to solve the more complex problems of the divided and reunited nerve ends. In one series of experiments Bethe evulsed the sciatic nerve at the greater sciatic foramen; thus destroying anterior roots and spinal ganglia. He then divided the nerve at the level of the middle of the femur. In a second series he divided the nerve and removed several centimeters from the central end. This end was then thrust through one muscle and sutured into another. His purpose was, of course, to prevent effectively any union between the ends of the central and distal segments. In spite of these conditions, Bethe obtained microscopic evidence of what he believed to be a regenerative process in the distal segment. He described five stages in the development of these autogenously regenerated nerve fibers: (1) development of protoplasmic bands;

(2) differentiation of these structures into axial strands and granular sheaths; (3) appearance of fibers; (4) fusion of fibers into bands, and (5) the discontinuous formation of a myelin sheath. The experiments of Langley and Anderson, Lugaro and of Segale showed the fallacy of Bethe's methods and results. His operative methods did not exclude the possibility of a downgrowth of axons into the distal segment from other nerves in the neighborhood still connected with the central nervous system. When these investigators severed all of the nerves supplying the lower extremity the evidence of autogenous regeneration in the sciatic nerve promptly disappeared.

Shortly after the beginning of the twentieth century, newer silver staining methods were described by Cajal, Bielschowsky and Ranson. These permitted of the exact description of the histologic picture which is present day by day in the central and distal segments of the degenerating and regenerating nerve.

#### MECHANISM OF DEGENERATION

**DEGENERATION OF DISTAL SEGMENT: *Myelinated Fibers:*** As early as eight days following section of a peripheral nerve Ranson found that the axons of the myelinated fibers were fragmented and appeared as small irregular clumps of granules which stained dark brown with the pyridine-silver technique. Some of the axons of the myelinated fibers are not broken up. They stain very intensely, have a uniform contour and the myelin sheath is intact. In the main the myelin sheaths become divided into elliptical segments. These are separated and surrounded by the abundant protoplasm of the cells of the neurilemma. The nuclei of the neurilemmal cells rapidly increase in numbers.

At the end of two weeks all of the myelinated fibers have become fragmented and thus there is the picture of the beginning, intermediate and final stages of degeneration. The myelin now appears as droplets which stain very intensely. At the end of nineteen days the small amount of protoplasm

about the nuclei in the normal fiber has rapidly increased and surrounds the droplets of myelin. As the fragments of myelin and axon absorb, this protoplasm almost completely fills the

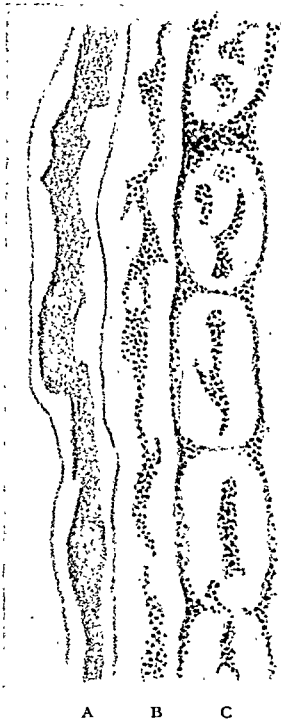


FIG. 91. A, Degenerating medullated axon in distal stump on second day; B, On fourth day; C, On eighth day. (After Ranson.)

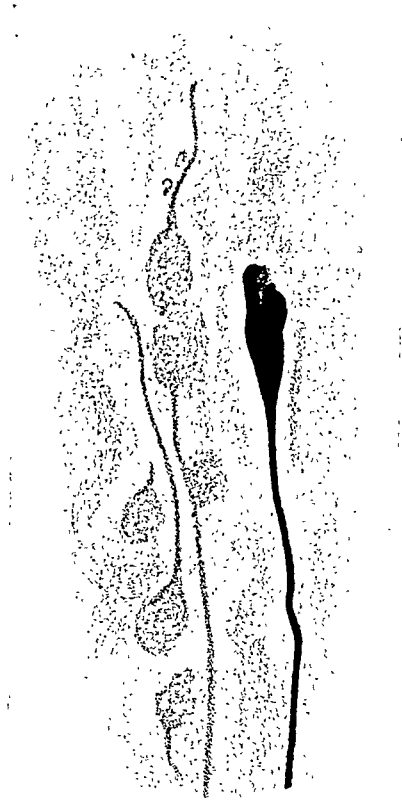


FIG. 92. Degenerating non-medullated fibers and their end bulbs. (After Ranson.)

old neurilemma sheath. These changes furnish the picture of a continuous band of protoplasm which contains many nuclei, droplets of myelin and darkly staining granules which represent the remains of the degenerated axon (Fig. 91). Three weeks after section only a few large droplets of myelin are seen because most of the detritus from the degenerating axons and myelin sheaths have disappeared. The protoplasmic bands of Büngner have a uniform contour and stain light yellow. Fine

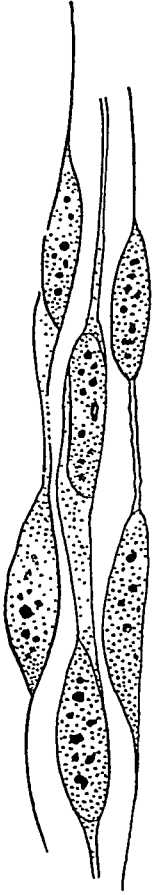


FIG. 93.

FIG. 93. Three protoplasmic bands formed from non-medullated fibers. From distal stump on nineteenth day. (Ranson.)

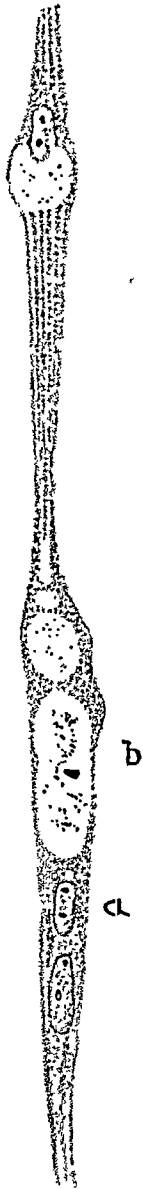


FIG. 94.

FIG. 94. Early protoplasmic band formed from a medullated fiber. From distal stump on nineteenth day. *a*, Nucleus; *b*, Droplet of myelin containing fragments of axon. (Ranson.)

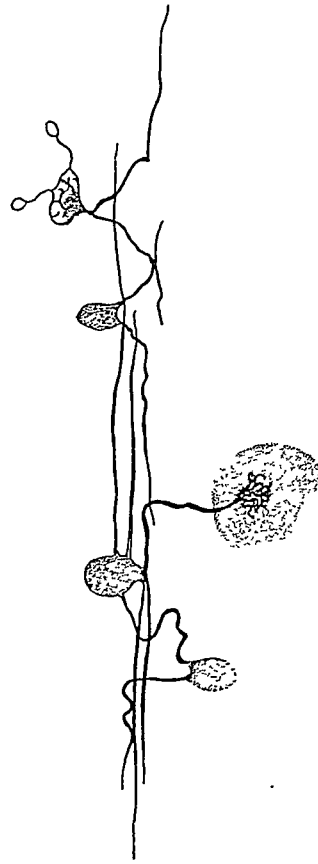


FIG. 95.

FIG. 95. Formation of side branches and end bulbs on non-medullated fibers near cut surface of proximal stump at end of first day. (Ranson.)

black granules, arranged in parallel rows are found scattered through the protoplasm and give to it a striated appearance.

*Non-Myelinated Fibers:* The majority of the axons of the non-myelinated fibers begin to degenerate within the first twenty-four hours after they have been separated from their cells of origin. They become granular and after three or four days appear to be segmented. Some of the segments are lighter and others are darker in color. Ranson states that the more darkly stained segments are fragments of the axon while the lighter stained segments represent an unstainable substance probably fluid in character (Fig. 92). By the eighth day the dark segments are no longer visible and the brown granular remains of the axons are scattered through the fluid content of the neurilemma sheath. By the nineteenth day the protoplasm of the neurilemmal cells has increased enormously in amount, the nuclei have multiplied and the continuous protoplasmic bands of Büngner are visible (Fig. 93). They differ from those found in the degeneration of myelinated fibers only in their size and the absence of myelin droplets. The degeneration of the non-myelinated fibers is complete by the end of four weeks.

These degenerative changes in the myelinated and non-myelinated fibers of the distal segment occur within a level of 0.5 cm. distal to the point of section and are characteristic for the remainder of the distal segment. Changes occur in the immediate neighborhood of the lesion, that is within the distance of a millimeter, which are essentially different (Fig. 94). They are well advanced within the first twenty-four hours. The non-myelinated fibers possess many side branches which are of equal diameter to the parent trunk fiber. The fiber and its side branches end in bulbs which contain a darkly staining core with a network of neurofibrillae. At the periphery of the bulb is a lightly stained zone which is quite thick but in which no neurofibrillae are visible. These numerous lateral branches and the large end bulbs separate the original fibers of a fasciculus. No change in the microscopic appearance of these fibers

and bulbs occurs between the first and fourth days (Fig. 95). By the eighth day the end bulbs are seen as shadowy outlines with a slightly more definite indication of the lateral branches. At the end of twenty-five days no evidence of their presence remains.

Similar early changes are found in the myelinated fibers near the lesion and these do not extend more than a millimeter distal to the section. They do, however, separate this zone from the rest of the distal segment which shows no distinct microscopic changes within the first twenty-four hours (Fig. 96). Near the line of separation between this zone and the remainder of the distal segment a definite reticulum of neurofibrillae forms. Fine fibrils leave this reticulum and independently run through the myelin. Some of them pierce the neurilemma and run into the endoneurium. Not all of the myelinated fibers show these early changes near the section but some are completely degenerated within four days. Ranson believes the more resistant fibers show the changes spoken of as abortive regeneration.

The change described in the degeneration of myelinated and non-myelinated fibers of the distal segment has no bearing upon ultimate regeneration of the nerve. All of the products of this reaction eventually disappear completely. They show that although that portion of a nerve fiber separated from its cell of origin ultimately degenerates, it may remain vital for two or more days. This vitality is sufficient to account for the appearance of lateral branches of the non-myelinated fibers and the independent fibrils arising from the reticulum of the myelinated fibers.

**DEGENERATIVE CHANGES IN THE CENTRAL SEGMENT:** Degenerative changes occur in the fibers of the central segment of the sectioned nerve. The degeneration takes place from the lesion toward the cells of origin but does not extend cellulipetally for more than 2 cm. (Fig. 97).

*Non-Myelinated Fibers:* Early abortive regenerative changes occur in the end of the central segment analagous to those



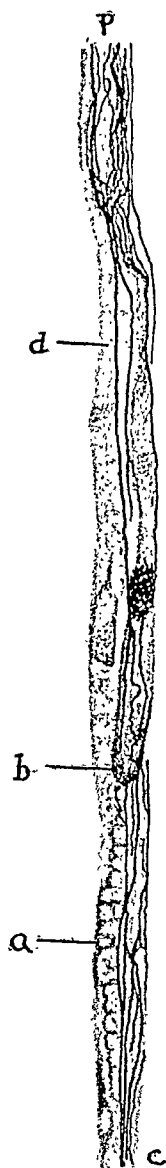
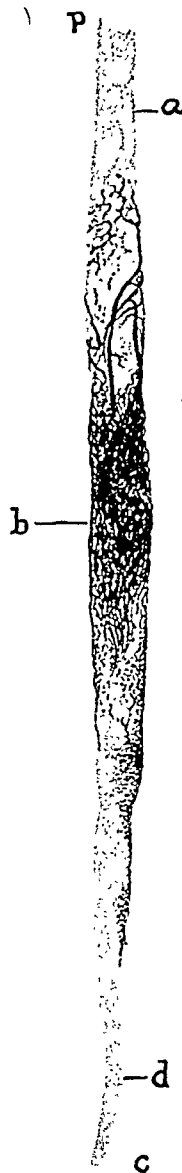


FIG. 96.



A



B

FIG. 97.

FIG. 96. Medullated fiber from neighborhood of cut surface of distal stump on third day. *a*, Disintegrated portion of axon; *b*, Club-shaped extremity of living part of axon; *d*, Isolated neurofibril. *c*, Toward center; *p*, Toward periphery. (Ranson.)

FIG. 97 A. Medullated fiber from neighborhood of cut surface of proximal stump at end of first day. *a*, Degenerated portion of fiber. *b*, Zone of reaction with neurofibrillar reticulum. *d*, Only slightly altered portion of axon. *c*, toward center; *p*, toward periphery. (Ranson.)

B. Medullated axon from neighborhood of cut surface of proximal stump at end of first day. Many fine branches arise from its surface and end in small bulbs. (Ranson.)

described in the zone immediately adjacent to the section in the distal segment. Ranson described spherical masses which appear on the side of a fiber, are thicker than the fiber and

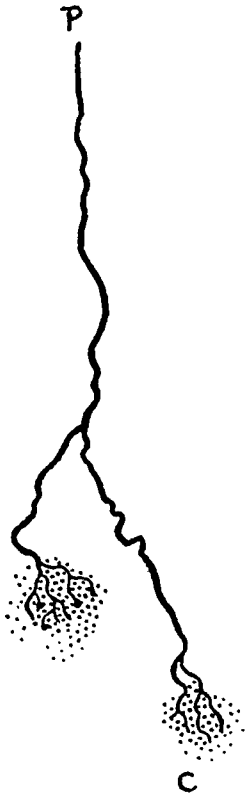


FIG. 98. Non-medullated fiber from neighborhood of cut surface of distal stump, showing branching and two end bulbs. End of first day. c, Toward center; p, Toward periphery. (Ranson.)

stain almost as intensely. He believes they have ameboid movement and that by working out of the fiber bundle in which it originated, they pull the fiber and form a u-shaped bend in it. Lateral branches are formed upon these non-myelinated fibers as they are on those of the distal segment and they have similar terminal end bulbs. The fate of these products of the early regenerative activity of the non-myelinated fibers in the central segment is the same as that in the distal segment.

Their development is less marked and their degeneration occurs earlier (Fig. 98).

At the same time that these changes occur in the zone

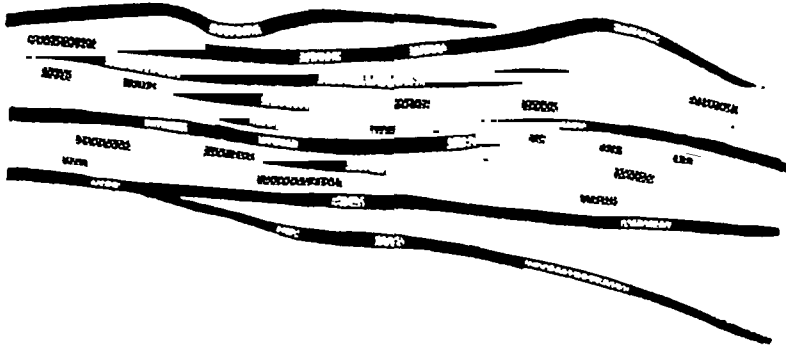


FIG. 99. Bundle of degenerating non-medullated fibers from distal stump on second day. (Ranson.)

immediately adjacent to the lesion, degenerative phenomena of varying advancement may be seen in the non-myelinated fibers. None of this evidence of cellulipetal degeneration extends centralward more than 2 cm. On the eighth day in the portion of the central segment extending from the cut end to a point 3 mm. above, the non-myelinated fibers may be recognized as a few shadowy outlines or as granular masses. From this point 1 to 2 cm. centralward, the non-myelinated fibers appear as alternately light and dark staining segments. This corresponds to the same changes which may be seen in the distal segment on the second day. It is important to recognize that although the microscopic picture is similar, the process of degeneration rapidly decreases in intensity as one traces it centralward and that it cannot be recognized 2 cm. above the site of the lesion. It is therefore a retrograde degeneration which is neither extensive nor complete (Fig. 99).

*Myelinated Fibers:* Immediately above the site of the lesion the disintegrated remains of the axon are visible. As one traces the process centralward the swollen axon, which completely fills the neurilemma at this point, gradually assumes its

normal size and staining reaction. In this zone of reaction the axon stains darkly and a dense deeply staining neurofibrillar reticulum is evident. In many myelinated axons there is an excessive accumulation of interfibrillar substance which pushes the neurofibrillae apart. This separation proceeds many times until the axon appears as a network of neurofibrillae forming a hollow tube. The myelin sheath disintegrates and this tubular network lies immediately beneath the neurilemma.

Some of the myelinated fibers show no evidence of retrograde degeneration and no zone of reaction is present. Such fibers are either less severely traumatized or are more resistant. They begin to grow immediately and their axons grow out of their sheaths into the surrounding exudate. Some axons give off fine fibrillar branches which end in long club-shaped end bulbs. Other axons give rise to very fine lateral branches which arise within the sheath. They course circularly and spirally to interlace with one another.

The zone of reaction, the dissociation of neurofibrils and the formation of tubular networks with the early outgrowth of collateral branches within the neurilemma were described first by Perroncito. These early changes in the myelinated axons of the central segment are also evidence of cellulipetal degeneration and their extent and duration are both short. However, the myelinated fibers give off lateral branches at a higher level and they first make their appearance as to the tubular networks begin to disappear. They are very numerous and run in the neurilemma sheath. Some of these fibers run a parallel course but others intertwine in a circular and spiral fashion. All of them have bulbous endings.

*Nerve Endings:* Immediately after nerve section evidence of degeneration in the nerve endings in striated muscle is visible in that the fibrils of the neurofibrillar net of the motor end plate stain lightly. The fibrils then enlarge and become fixed to one another. This proceeds until an intensely darkly staining mass of irregular strands is formed. These in turn clump together, become fragmented and form irregular masses which

eventually disappear. The axons of the sensory end organs disappear completely.

*Nerve Cells:* Evidence of degenerative changes is present

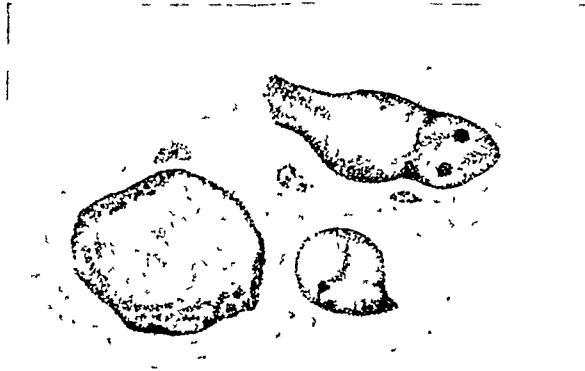


FIG. 100. Degenerative reactions in spinal ganglion cells following peripheral nerve injury.

in the cells of origin of a nerve fiber after its section. These changes have been termed chromatolytic and their extent depends upon the type of trauma and the proximity of the trauma to the cell. Rather indistinct changes are to be seen within the first twenty-four hours but after the second or third day the Nissl bodies within the cytoplasm of the anterior horn cells become pale and the cell becomes swollen and rounded. The nucleus becomes excentrically placed. These changes are the expression of a functionless anterior horn cell.

The degenerative reactions in the spinal ganglion cells possess all of the characteristics of chromatolysis. The process of degeneration varies in intensity in the different cells. While only a small part may ever show complete degeneration, at least 85 per cent show evidence of chromatolysis. The small cells, however, suffer in the greatest numbers. These are the cells which give rise to non-myelinated fibers. This explains why the majority of cells in a spinal ganglion react to a peripheral nerve lesion although the number of myelinated fibers in the nerve may be very small (Fig. 100).

## MECHANISM OF REGENERATION

In describing the degenerative changes which occur in the distal segment we have spoken of the formation of protoplasmic bands first described by Büngner. Kirk and Lewis and many other authors believe that this phenomenon is of the greatest importance in the regeneration of nerves.

There is an early hyperplastic reaction to the neurilemma sheath so that its cells revert to an active or embryonic type. The cytoplasm surrounding the nuclei of the neurilemma cells increases rapidly in amount and the nuclei divide by mitosis. The protoplasm of the cells becomes connected into narrow bands containing the hyperchromatic and actively dividing neurilemmal nuclei. They completely fill the neurilemma sheath. This process is particularly active in the immediate neighborhood of the nerve lesion. This may be looked upon as a means of Nature to secure a pathway for regenerating axons. It is interfered with in many instances by the ingrowth of extraneous connective tissue, a more complete description of which will be given later.

Ingebrigsten has incubated peripheral nerves in plasma and has noted the outgrowth of thin filaments of highly refractile and slightly granular protoplasm. These are at first tapering and end in a point which shows ameboid movements and which merges into the plasma. Soon they become cylindrical, branch and anastomose. The nuclei found in the bands are ovoid and fusiform in shape (Fig. 101).

There have been many investigators who have corroborated the statement of Howell and Huber that before any axons grow from the central to the distal segment, the protoplasmic bands grow across the intervening gap and prepare the way. As early as the first day after the lesion some of the axons of myelinated fibers grow into the exudate and break up into many fine branches. Other axons give rise to lateral branches within the neurilemma sheath. These branches always have a typical bulbous end. Some of these branching fibers run a

parallel course while others run into tangled skeins and never reach the exudate but turn back upon themselves. Regeneration in the unmyelinated fibers begins on the fourteenth day

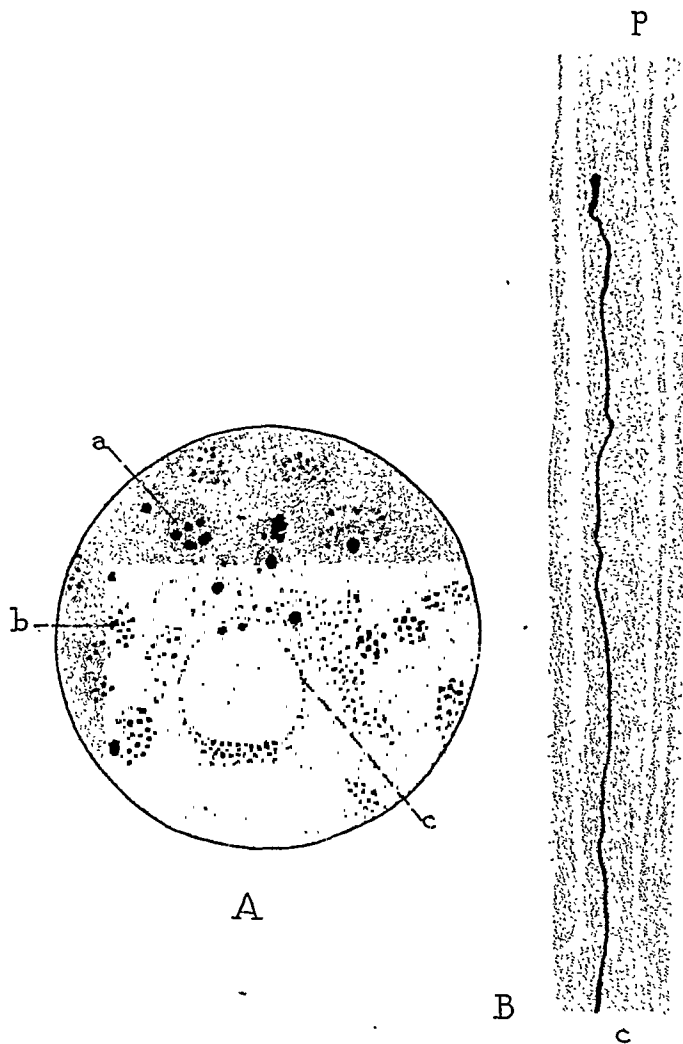


FIG. 101. A. Cross section of distal stump on thirty-fourth day. *a*, Protoplasmic band from a medullated fiber containing five new axons. *b*, Bundles of protoplasmic bands from non-medullated fibers some of which contain new axons. *c*, Droplet of myelin in a protoplasmic band.

B. Five protoplasmic bands, down one of which a new axon is growing. From distal stump twenty-four days after operation. *c*, Toward center; *p*, Toward periphery.

and the axons begin their downward growth above the point

in the central segment where cellulipetal degeneration ceased. These axons have lateral branches and their ends have bulbous tips. As the new downgrowing axons penetrate farther into

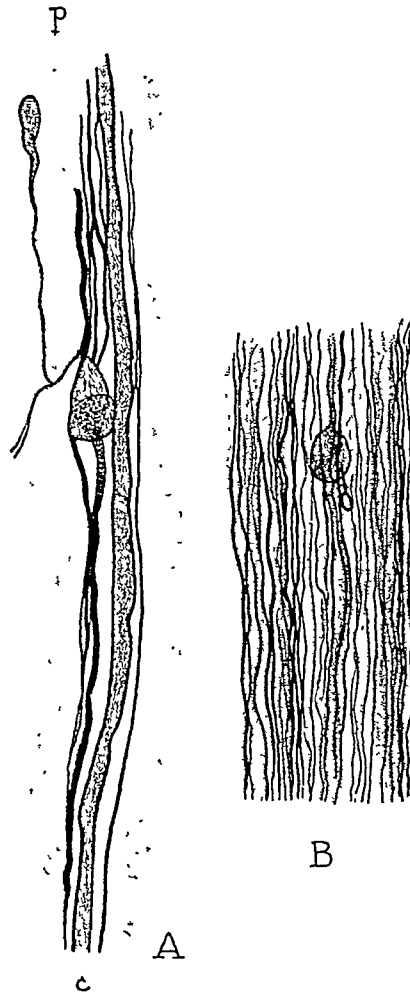


FIG. 102. A. Branches of medullated axon of proximal stump several millimeters above cut surface on twenty-fifth day. C, toward center; P, toward periphery.  
B. Bundles of new axons in proximal stump on thirty-fourth day.

the distal segment they tend more and more to assume a parallel course and thus the spiral, circular appearance more common nearer their level of origin is lost (Fig. 102).



The source of the sheath of myelin about some of the new axons, all of which are at first non-myelinated, is as yet undetermined. It has been stated that it is the product of neurilemma cells and that it represents a differentiation of the outer layer of the axon. The myelin sheath may be recognized in the newly formed fibers of the central segment at the end of the first month after injury as a very delicate structure. Its formation proceeds distalward from the central segment at a very slow rate. According to Huber the experimental evidence and the structural appearance strongly suggest its origin from the peripheral layer of the neuraxis.

There is no reason to assume from any of the experimental work that the downgrowing axons show any selectivity as they reach the distal segment. Motor fibers enter the neurilemma sheaths formerly occupied by sensory fibers and vice versa. Functional regeneration under such conditions is probably impossible because of the specialized terminal nerve endings. Some observations have been noted which tend to show that the nerve endings attempt to change their structural character under such conditions.

Motor nerve endings in striated muscle in the process of regeneration appear to be branches from terminal end discs or as end branches of collateral fibers which reach the muscle fiber within the old neurilemma sheath. Boeke demonstrated that many muscle fibers show more than one motor nerve ending, so that there may be an hyperplasia under the conditions of regeneration. It has been shown that non-myelinated nerve fibers may be shown within the capsule of muscle or tendon spindles although no ending could be found. The sensory nerve endings therefore probably regenerate later than do the motor nerve endings.

It may be seen throughout the entire description of the process of degeneration and regeneration that the neurilemma sheath, in one way or another, plays a very prominent rôle. The necessity for its presence in the regeneration of any part of the nervous system may be emphasized again.

## CHAPTER XVII

### INDICATIONS FOR SURGICAL TREATMENT

The most important duty of a doctor to a patient who has a nerve injury is to determine at the earliest possible moment the severity of the lesion. It has been well established that as in the case of spinal cord injuries, the early symptoms of a complete physiological interruption of a peripheral nerve cannot be differentiated from a complete anatomical section. If this were possible it would of course materially increase the success of nerve repairs because early operative interference could be instituted.

Although dogmatic laws cannot be laid down by which such a differentiation may be made there are several factors which are of distinct aid. It is important to obtain a careful and accurate history of the character of the injury. For example, stab or cutting wounds are more than likely to produce a division of the nerve trunk, whereas a blunt force applied to the course of the nerve trunk may produce a physiological interruption without severance of nerve continuity. The application of such a force to the nerve in a part of its course where it is well protected by muscles would be less serious than if the injury were over a more superficial portion of the nerve. Again, fractures of bones may compromise the nerves in close relation by involvement in bony callus or by anatomical section between bony fragments. The relation of the course of any given nerve to the direction or depth of a wound must be reconstructed in order to determine if possible the severity of the nerve lesion. Unfortunately, in injuries of some duration the development of scar tissue may compress a nerve trunk so that it will be impossible to state whether or not there was an anatomical lesion earlier.

Several observers have attempted to establish certain syndromes which would make it simple to distinguish between anatomic and physiologic interruption of the nerve fibers.

If these groups of symptoms had an absolute diagnostic value the problem of surgical treatment would be simpler. However, they have not been verified and established by clinical investigations.

As we have stated before, we believe that there is no way by which complete loss of function due to an anatomical interruption can be differentiated from that due to physiological interruption of nerve fibers. From a single examination we are able to state whether or not the loss of function is complete or incomplete. In the presence of a complete physiological interruption of function, we may say that the lesion will recover spontaneously only when subsequent examinations show some return of function in motion, sensation or electrical stimulability.

We consider that (1) complete paralysis of all muscles supplied by a nerve below the level of the lesion; (2) complete loss of sensation over the isolated sensory distribution of the nerve; and (3) the complete reaction of degeneration, when present together, to be the only reliable signs of a complete interruption of function in a peripheral nerve.

As has been stated, while these symptoms make it possible to diagnose an interruption of function, it is still impossible to say in a number of cases whether or not anatomical severance has occurred. There is therefore the possibility of operating upon a nerve trunk which is not severed. In many instances of anatomical section one may be able to palpate the distinct neuromas upon the ends of the divided nerves. This finding of course makes surgical interference more strongly indicated. Physiological interruption may recover spontaneously in a large number of instances. Consequently our practice in the presence of a complete nerve interruption in which no evidence is available as to whether or not there has been an anatomical severance, is to wait for any evidences of recovery before the injury is treated as an anatomical section. During this time it is extremely important to make careful and repeated examinations for any signs of regeneration. It must be recognized that

unless one is familiar with the sensory pattern of recovering nerve lesions, reliance upon sensory examinations alone is rather hazardous.

The period necessary for the spontaneous regeneration of a nerve is quite variable. It depends upon the nature and extent of the injury and also upon certain characteristics of the individual nerve trunks, the reasons for which are not entirely known. Consequently, the next point to be considered is just how long a nerve injury should be treated conservatively before a decision is made to explore the lesion surgically. If one waits too long, muscle atrophy and degeneration of sensory nerve endings may make a complete return of function impossible. Bénisty believes that there is no danger in waiting four to five months after the lesion has been received. On the other hand, it is not uncommon to encounter lesions in which it is impossible to attempt a repair before many months have elapsed because of the fact that the wound is infected. Foerster has stated that the length of time of the operation after the receipt of the wound is never a contraindication to operation. In other words, it is never too late to do a nerve suture. However, it has been proved that the success of nerve suture is in direct relation to the interval between the receipt of the wound and operation.

It is important, therefore, to recognize and evaluate the early symptoms of nerve regeneration because an operation is unjustified if there is evidence of recovery. Bénisty has given the order in which the signs of a spontaneous regenerating lesion appear. They are (1) the presence of pain upon pinching the skin in the sensory area supplied by the nerve; (2) formication upon pressure of the nerve below the site of the lesion; (3) spontaneous aching in certain muscles; (4) arrest of muscle atrophy and return of tonicity; (5) disappearance of objective sensory disturbances; and (6) the return of voluntary movements. We believe that in spontaneously recovering lesions in which surgical interference is contraindicated, there is a return of pin prick and touch sensation simultaneously. In other

words, there is no dissociation of sensation. In some 200 peripheral nerve injuries which were incomplete and recovered soon after injury there were only three in which sensibility to pin prick was present and touch sensibility was absent. We believe further that Tinel's sign, or peripheral formication upon pressure or light percussion of the nerve trunk distal to the lesion, is not a reliable sign of recovery of function. In the interpretation of the return of motor power in relation to recovery of function the development of supplementary movements is an important factor which may lead one to a fallacious conclusion. These supplementary muscle movements have already been described. It may be well to emphasize again that some muscle movements cannot be supplemented and upon the presence or absence of these must depend the indications for operative treatment. In radial nerve lesions, for example, extension of the proximal phalanx of the thumb, abduction of the thumb in the plane of the palm and active extension of the proximal phalanges of the fingers cannot be imitated by supplementary movements. In ulnar nerve lesions, flexion of the proximal phalanges of the ring and little fingers with the distal phalanges extended and lateral movements of the extended middle finger cannot be imitated. Likewise in median nerve lesions the ability of the patient to flex the distal phalanges of the index finger and thumb should be examined. In combined lesions of the ulnar and median nerves the ability to increase the concavity of the palm and to flex the wrist slightly are the only movements which can be produced by supplementary action. Similarly in peroneal lesions, the only movement which cannot be supplemented by other unparalyzed muscles is eversion of the foot.

Of all of the signs of a regenerating nerve which have been described, it is generally agreed that the disappearance of the reaction of degeneration, the return of sensation in the isolated supply of the nerve and the return of movements which cannot be supplemented are the only reliable ones. We would say in a general way that if there is no evidence of regeneration from

four to five months after complete paralysis of the radial and peroneal nerves, a surgical exploration should be performed. Likewise the fifth month may be considered the maximum time to wait for recovery in a complete paralysis of the ulnar nerve. The median and sciatic nerves regenerate very slowly and unsatisfactorily and the sixth month without evidences of regeneration should indicate surgical interference. Despite the fact that these time limits are recommended there were many cases in our series in which symptoms of recovery began at the ninth month following injury.

We have just discussed the indications for operation in the group of nerve injuries in which there has been a complete interruption of function either because of anatomical section or physiological interruption. If there are definite evidences of an anatomical severance, repair should be done immediately. If these signs are absent, we may wait a reasonable time for evidences that the lesion has begun to recover. If these are absent the lesion is treated as one of severance. In addition, however, there are a group of lesions in which complete interruption of function is not present. These are partial lesions which give rise to incomplete paralysis. A stab wound may produce severance of only a few fibers, or scar tissue may compress a nerve only partially. Practically, the same principles apply to these lesions. The prognosis for recovery is doubtful if partial interruption exists and yet there are no responses to electrical stimulation of the involved muscles. These cases must be studied carefully because attempts at surgical repair may be followed by more loss of function than already exists.

In addition to the indications for surgical interference already given, there are other factors which may influence the surgeon's decision about the advisability or time of operation. For example, an aseptic field is a *sine qua non* for a successful result in a nerve repair. Infection is perhaps the most common cause for failure following a nerve suture. The problem often arises as to whether or not a severed nerve should be sutured immediately in a primary wound. Naturally this will depend

upon the type of wound and the probabilities of it becoming infected. A glass cut or stab wound is not likely to be followed by infection while on the other hand a crushing lacerated wound which has been produced by a dirty or greasy force may be assumed to be infected. Therefore, it is our practice to suture the nerve immediately in a primary, relatively clean wound. If the wound remains clean and heals by primary intention we have taken advantage of the best possible conditions under which an end-to-end suture may be performed. If, however, the wound does become infected, we have the advantage of having the ends in apposition so that at a later date the scar tissue which surrounds the nerve suture may be resected or if necessary a secondary resection and end-to-end suture may be performed. If it is obvious that the wound is infected it is wiser to anchor the nerve ends together so that retraction and large neuromas may be avoided. Nerve injuries may be present in large destructive wounds of the soft tissue in which it is obvious that there will be a large amount of scar tissue which will interfere with the regeneration of a primary end-to-end suture. Here too apposition of the nerve ends should be done to facilitate the secondary operation of end-to-end repair which will be necessary.

If the wound becomes infected or if a patient presents himself with a healed wound which previously has been infected it is important that the secondary suture should be delayed until the dangers of recrudescence of the infection are minimal. Foerster waits from six to eight weeks after an infected wound has become healed; Auerbach a full eight weeks. Marburg and Kranzi and Shoele advocate an interval of from four to six weeks before the secondary suture is performed. This is an important factor, as has been stated, and it is wiser to wait somewhat longer than may actually be necessary to avoid any possibility of lighting up dormant bacteria. It is our policy to wait at least twelve weeks after the wound has become clean. This length of time will not affect the result of the regeneration provided, of course, that the muscles

and joints are kept in condition which will make them effective mechanisms when regeneration does occur. It is advisable at times to massage the healed wound and observe the systemic and local reaction which may follow if bacteria are still present which may become active upon surgical intervention.

The problem of the repair of a nerve lesion in the presence of a fracture may present itself. The indications for repair of the nerve in any open wound will guide one in the presence of a compound fracture. In a simple fracture it is advisable to treat the fracture primarily and to wait until firm union has occurred before repair of the nerve lesion is attempted. A pseudoarthrosis may easily spell failure to an otherwise successful nerve suture. On the other hand, one must expect the callus of a healing fracture to involve an adjacent nerve trunk rather seriously. One must remember that here too if the effector mechanisms are treated intelligently one may wait for a relatively long period and still obtain a good result from a nerve repair.

Though a wound may not be infected, there may be a large area of skin necrosis or an extensive destruction of tendons and muscles. Naturally under such circumstances it is wiser to delay nerve repair until it is possible to insure a relatively healthy bed of surrounding tissue or until the effector mechanisms have been repaired.

Granted that one has determined upon a nerve exploration, the problem of just what should be done surgically arises. This is, of course, dependent to a large extent upon the surgeon's experience. The nerve trunk may not appear to be divided anatomically. We have observed scar tissue bridges between nerve ends which grossly have appeared like normal nerve. Or, the nerve trunk may be quite intact grossly and yet contain no viable fibers at the site of injury. A good rule to follow is that if there is no response from stimulation of the nerve by a faradic current above the lesion there are no viable fibers and resection and suture is indicated. If most but not all of the muscles react upon nerve stimulation, that is,



if there is a dissociated paralysis and no interruption of continuity, one may perform an endoneurolysis with chances for a considerable degree of success. Or, under the same circumstances, if there is a large amount of scar tissue surrounding the nerve, neurolysis may be performed. While it has been assumed that these procedures hasten recovery this fact has not been proved.

Following a carefully performed operation of end-to-end suture the evidences of regeneration may be present and then suddenly cease to progress. One must be very conservative about planning upon a second operation under such conditions. Many times this retardation of recovery may be temporary and the signs of regeneration may again appear. However, if after a reasonable length of time the signs of regeneration do not progress the suture line should be explored. One may find a small amount of scar tissue about the suture line which has impaired further progress. No definite time limit can be set to wait for these signs to appear because they vary with individual nerves and the characteristics of the particular operative field which has been present. However, at least nine months should elapse before a second operation is performed following a carefully executed end-to-end suture.

It is obvious that we cannot lay down dogmatic indications for surgical procedure in all nerve lesions. The chief aims of the surgeon should be to have respect for the continuity of a nerve and not to perform resections too hastily; to obtain an end-to-end suture as soon as possible after section of a nerve trunk; to regard infection as an important obstacle to nerve regeneration; and finally, to keep in mind the delicacy of nerve tissue and the difficulty of its repair.

## CHAPTER XVIII

### METHODS OF NERVE REPAIR

During the development of the surgical treatment of peripheral nerve injuries many methods of surgical repair have been described. These methods are all alternative to the method of choice which is, of course, direct end-to-end suture of the nerve ends. Unfortunately, all of the suggested procedures are not based upon established physiological, histological or anatomical principles. The mass of experimental and clinical evidence which has accumulated upon these methods, particularly during and since the Great War, may now be analyzed and evaluated rather accurately. Such analyses only emphasize the wide gap which exists between the functional results obtained by end-to-end nerve suture and those which follow the most successful of the alternative methods of repair.

The several methods of peripheral nerve repair may be listed as follows:

- Nerve transplants or grafts
- Nerve implants
- Nerve crossing
- Nerve flaps
- Suture *à distance*
- Tubular suture
- End-to-end suture.

#### NERVE TRANSPLANTS

As now generally understood in the literature, nerve transplants or grafts means the interposition and suture of a segment of nerve between the divided ends of a nerve. Nerve transplants may be classified according to their origin and type. *Autogenous* transplants consist of nerve segments obtained from the same individual. For example, a portion of the superficial branch of the radial nerve may be used as a graft to repair

a defect in the median nerve. *Homogenous* transplants are obtained from an individual of the same species. An example of this type of a graft is a nerve segment removed from an amputated extremity to bridge a nerve gap. Lastly, a nerve transplant may be taken from an individual of a different species. A nerve segment taken from a lower animal to bridge a nerve defect in man is known as a *heterogenous* graft. These transplants may consist of several segments of equal length or of a single segment of nerve: hence, the terms *cable* and *single* grafts.

It has been quite impossible to check the clinical results which have been obtained after the use of transplants as closely as have the experimental investigations been followed. Consequently, while the experimental results have seemed to be quite promising the clinical results have been disappointing. Philipeaux and Vulpian, in 1869, were the first to use an autogenous nerve transplant experimentally. They resected a segment of the hypoglossal nerve of dogs and bridged the defect with a lingual nerve segment. In 1895, Huber carried out experiments with each of the three types of grafts in twenty-six experiments. Ten of these animals were kept four months or longer before a functional and histological examination of the nerve was made. In five of these animals, all of which were heterogenous transplants, the results were satisfactory. In four others the regenerating axons had passed the transplant and entered the distal segment. Forsmann, Merzbacher and Segale have suggested that autogenous and homogenous nerve grafts survive and are capable of exhibiting degeneration changes; whereas an heterogenous transplant did not survive in the host because of necrobiotic changes. Maccabruni, however, could find no difference in the behavior of the three types of transplants. Ingebrigsten, in 1915, stated that the survival and multiplication of the cells of the sheath of Schwann formed the only reliable evidence of viability of the transplant and if the grafts became necrotic they were of no more value than catgut strands. Later he stated that he had

observed evidence of Wallerian degeneration in autogenous and homogenous transplants exactly similar to those which occur in the distal end of a divided nerve. However, in heterogenous grafts the nerve became necrotic in about two weeks and was therefore functionless. In 1918, Ingebrigsten came to the conclusion that the cells of the sheath of Schwann have no functional significance in the transplants and that the axons grow into the transplant from the central end of the divided nerve, whether the transplant lives or dies. In later experimental work carried out during the Great War, Huber came to the conclusion that Schwann sheath cells play an unimportant rôle and that regeneration of the distal segment may be obtained with all three types of transplants. However, he stated that the result is less certain and the time required longer with heterogenous grafts. Consequently, Huber does not recommend them for clinical use.

In 1918, Dujarier and François reported rather incompletely their results in twenty cases with homogenous transplants which had been taken from amputated extremities and stored. In order to preserve these grafts after they had been removed aseptically, they were placed in sterile white vaseline which had been placed in a tube and melted in a water bath. After the tube had been sealed carefully it was placed in a thermos bottle half filled with water. The graft was always kept at about zero. Nerves were preserved in this manner for as long as forty-one days. Before using the transplants the vaseline was melted and rinsed off in warm serum. They reported only one instance of suppuration and loss of the graft. At the time of the report three cases had been examined after a period of from three to five months and in two there is said to have been signs of return of sensation but none of motor activity. Nageotte performed similar experiments with homogenous transplants but stored them in .50 per cent alcohol.

Huber repeated this work experimentally and used alcohol and liquid petroleum instead of vaseline as storage media.

He reported that on the whole the results of these experiments were satisfactory. Functional return was present in all of the experiments of long duration. He also concluded that stored homogenous transplants were quite as satisfactory as the fresh grafts. In all of his experiments neuraxes from the central stump could be traced into the transplant and through it into the peripheral stump. Many of these neuraxes seemed to lie within what remained of the neurilemma sheaths of the transplanted nerve fibers. Equally good results were obtained with alcohol or liquid petroleum stored transplants. Huber stated that there is no evidence that any of the cells of the transplanted nerve segment proliferate and he feels that little if any viability is retained in the graft particularly when it has been stored in 50 per cent alcohol. Using liquid petroleum stored heterogenous transplants, regeneration of the distal segment through the transplant could not be demonstrated in any experiment. Similar experiments with heterogenous grafts stored in alcohol showed a like failure in results.

Coincidental with the use of transplants there arose the practice of protecting the suture line of a nerve repair or the transplant by wrapping it with various membranous materials. The number of these materials is almost unlimited. Morris first used Cargile membrane, which is the dried and sterilized peritoneum of the ox, for experimental purposes. He found that it resisted absorption for more than ten but less than thirty days when it was placed in the abdominal cavity. Craig and Ellis wrapped nerve and tendons with the material and concluded that it prevented adhesions about these structures, particularly when they were surrounded by traumatized tissue. The importance of such an observation was great. It was used clinically by many surgeons and reported upon by Sherren, Meuriot and Platon, and others. It was found that the membrane was absorbed from about a nerve in ten to fifteen days. By the end of six weeks no trace of it could be found. Such a membrane, to be effective in preventing the ingrowth of connective tissue between the ends of the nerve,

should remain for at least two months. Consequently, it was concluded that plain Cargile membrane was of little or no value. On the other hand, the experiments showed that the same membrane stored in 50 per cent alcohol remained as an effective barrier against ingrowing scar tissue for as long as four months. It does not, however, influence the downgrowth of neuraxes into a transplant or into the distal segment of a nerve united by end-to-end suture.

Huber also carried out a series of experiments in which the autogenous transplants were wrapped in autogenous fascia lata sheaths, formolized arteries and fat transplants. It was found that the fascial sheath resisted absorption for as long as a year. There was, however, a proliferation of connective tissue about the sheath which was more marked than that found about Cargile membrane. The experiments in which hardened arteries were used as sheaths confirmed Foràmitti's original contention that there was little connective tissue proliferation excited in the surrounding normal tissues. There was no evidence of a secondary contraction of the arterial sheaths and they resisted absorption a sufficiently long time. Formolized arterial sheaths may be prepared from the carotid arteries of large dogs, stretched over glass tubes, fixed in 5-10 per cent formalin for forty-eight hours; washed in water for twenty-four hours; boiled in distilled water for twenty minutes and stored in 70-95 per cent alcohol. They are, therefore, as practical as Cargile membrane but have no definite advantages over the latter. Fat was used as a protective sheath, both as a free transplant and as a pedicled flap. Huber found that a free autogenous fat transplant was quickly replaced by dense fibrous connective tissue. No conclusions were made concerning the pedicled fat flaps. We have used pedicled fat transplants about nerve suture lines when the nerve could not be placed in a healthy muscle plane, which is, of course, the best method of protection. The clinical results in these cases have not led us to believe that the fatty tissue in any way interfered with the downgrowth of neuraxes. Experiments which

have been carried out upon tendon sutures seem to show that similar pedicle fat flaps have served the purpose quite adequately.

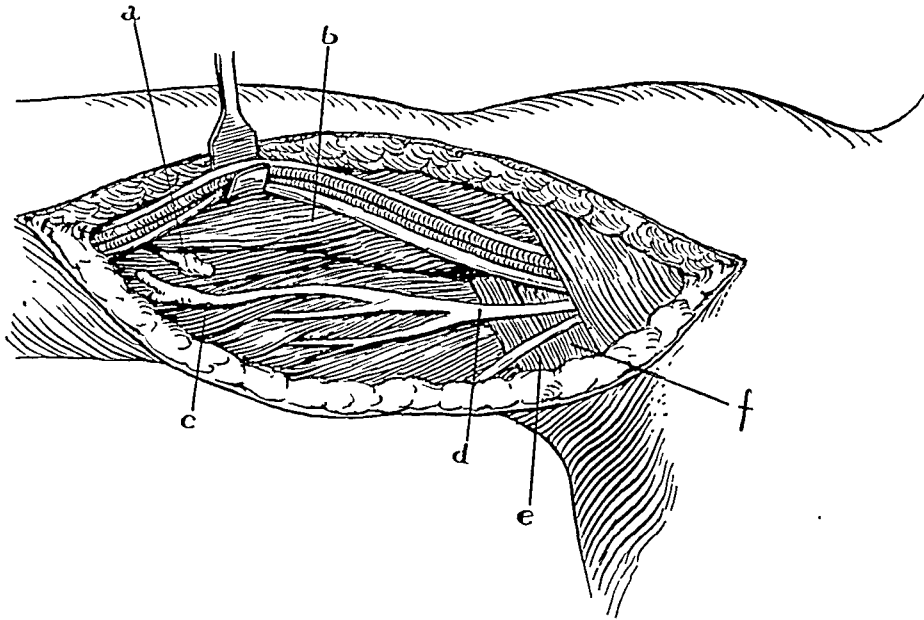


FIG. 103. Nerve transplantation: distal and central ends of radial nerve are withdrawn from their normal course to lie upon medial side of arm. *a*, Distal end of radial nerve. *b*, Biceps, *c*, Triceps. *d*, Radial nerve. *e*, Teres major. *f*, Latissimus dorsi.

In operations upon human cases, the medial cutaneous nerves of the forearm and arm, the superficial branch of the radial, the saphenous, posterior cutaneous branch of the femoral and the lateral, and medial cutaneous branches of the sural nerve have been utilized as transplant material. It is obvious that many difficulties may be encountered in performing a transplant operation. The grafts must be sutured very accurately because, unless the ends are in exact apposition with the central and distal ends of the nerve trunk into which it is placed, the chances for a successful growth of neuraxons are greatly diminished. This fact alone may account for the disparity in the clinical results which have been reported.

The success of this method of repair will be discussed in detail in the chapter which deals with the results of operative treatment. (Fig. 103.)

### NERVE IMPLANTS

In 1873, Létiévant suggested that the central end of the distal segment of a divided nerve might be implanted into a slit made into the trunk of an adjacent sound nerve. This method presupposes that the nerve fibers of the sound nerve will grow down into the distal segment of the divided nerve. If the funiculi of the sound nerve are merely pushed apart and the implanted nerve end placed between them no neuraxes can be available. If however, the funiculi of the sound nerve are cut, the downgrowth of neuraxes into the implanted segment becomes theoretically possible. However, if this is done the method then ceases to be a true implantation and is in reality a partial operation of nerve crossing. It is understood under such conditions that the normal nerve funiculi are injured and paralysis in the distribution of the sectioned fibers will result. Huber's experimental work, in 1895, showed that truly implanted nerve segments showed no histological or physiological evidences of a downgrowth of neuraxes from the sound nerve trunk.

Hofmeister has suggested a method to be used in bridging defects of one or more nerves of an extremity if there exists an accompanying normal nerve trunk. This comprises in effect multiple implantations of the ends of both central and distal segments into slits made in the normal nerve. His contention is not the normal nerve into which the ends are grafted assists in direct neurotization of the distal segment but that it acts as a favorable medium for the downgrowth of central neuraxes into the peripheral end of the divided nerve (Fig. 104).

Experimental evidence does not support this procedure because the irregularity with which central neuraxes grow



downward is well known. Particularly would this be true if they met the resistance of the endoneural and perineural connective tissue of the normal nerve's funiculi.

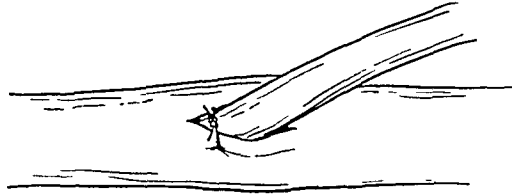


FIG. 104. Nerve implantation.

### NERVE CROSSING

The procedure of nerve crossing has been confused with that of nerve implantation. It is probable that every functional result obtained with a so-called nerve implant has been because a certain number of fibers of the sound nerve have been injured and thus a partial nerve crossing has been effected. Nerve crossing, therefore, consists of the suture of the necessary sectioned part of a sound nerve to the distal segment of an injured nerve (Fig. 105). If an entire sound nerve is used it is necessary to evaluate the loss of function produced by its sacrifice against the return of function which one desires to obtain. One of the basic principles of nerve crossing is that the nerves used should have a comparable physiologic supply. For example, Flourens, in 1827, showed that it was impossible to obtain a functional result by suture of the fifth cervical nerve to the vagus. On the other hand, he cut the two principal trunks of the brachial plexus in a cock and sutured the peripheral end of the trunk which supplies the upper surface of the wings to the central end of the trunk which supplies the lower surface of the wings. After several months there was complete recovery of function and Flourens verified this result by direct stimulation.

While Cannon reports to have sutured the central end of the phrenic nerve to the distal end of the cervical sympathetic and thus obtained a rhythmical stimulation of the thyroid gland with each respiratory movement, others have been unable to

confirm this experiment. While it may be proved histologically that there is a downgrowth of neuraxes, a complete return of physiologic function does not occur. Langley and Anderson

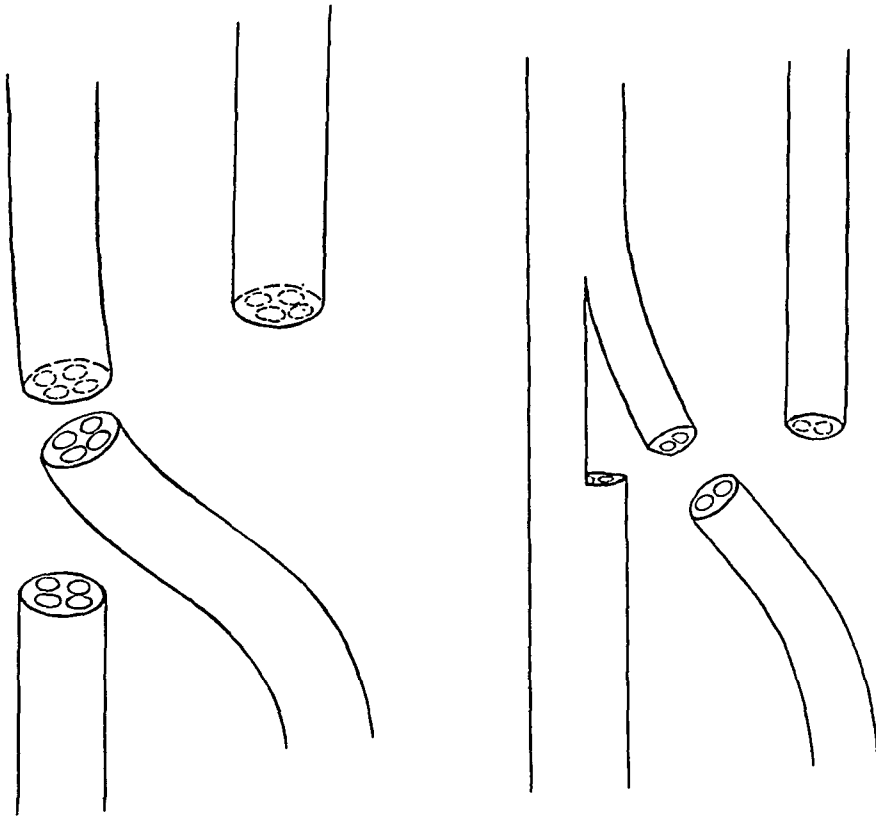


FIG. 105. Nerve crossing.

traced fibers from the femoral nerve into the saphenous nerve and Boeke was able to trace nerve fibers from the hypoglossal which had been crossed to the lingual as far as the epithelial cells in the tongue. Philipeaux and Vulpian's work in 1870, is contrary to later experiments in that they concluded that sensory and motor fibers would unite and that stimulation of one produced a correct effector response in the other. In general, in applying this method of repair in peripheral nerve surgery, one should suture motor to motor, sensory to sensory and mixed to mixed nerves.

The problem, therefore, with which one is faced is not primarily whether or not neuraxons will grow into the distal segment of the injured nerve. Rather it is to obtain this result by the use of nerves whose physiologic function is similar. This may not be extremely important when gross muscle movements are involved but it is important when the accurate movements of the small hand muscles or the emotional expression movements of the face are concerned. If two motor nerves which supply synergic groups of muscles whose action produces simple movements are crossed the resulting disturbance of the coordinated movements may be slight. On the other hand, the inability to dissociate movements of the shoulder and face after a successful spinal accessory-facial nerve crossing may be very disturbing. There is no evidence that the cortical cells which supply innervation to a group of muscles changes in any way to meet the functional demand of muscles which become innervated by means of the nerve crossing.

#### NERVE FLAPS

The method of bridging defects by the use of nerve flaps made from the central or distal ends of a nerve, or both, was first suggested by Létiévant. Many reports of such cases may be found in the literature. Among them are those of Tillmanns, McKenzie and others.

In performing this procedure one-third to one-half of the central end of the nerve is cut across and turned downward at an acute angle to be sutured into the distal stump. The opposite procedure is performed in the construction of a flap from the distal to the central segment. As already stated, both central and distal flaps may be made and sutured in apposition. It is obvious that in a central flap many neuraxes are permanently destroyed and since the fibers are separated from their cells of origin, their subsequent regeneration is impossible. The central flap is therefore nothing more than a degenerated nerve segment. The tissue which bridges the gap is soon only connective tissue with degenerated axons and proliferated

Schwann sheath cells exactly as one finds in the degenerated distal segment of a divided nerve. In addition to the failure to perform the function intended there is an additional resultant

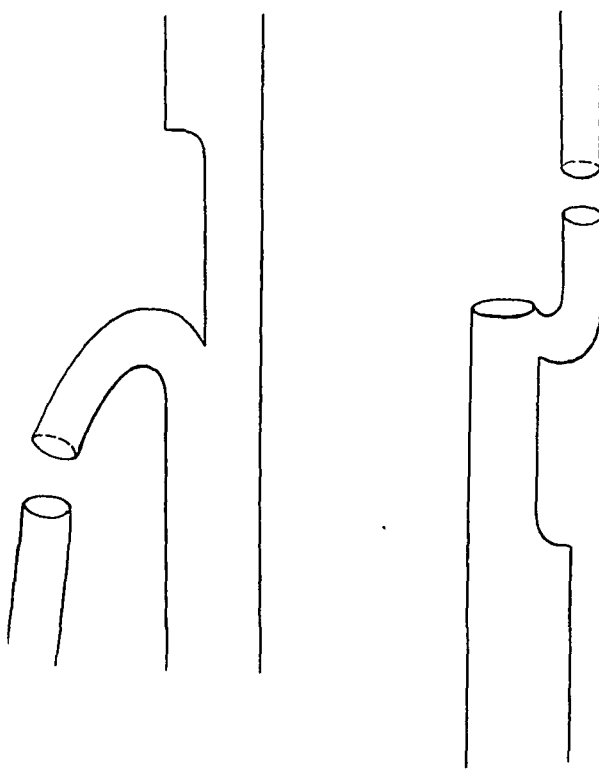


FIG. 106. Nerve flap method of repair.

permanent damage to the involved nerve. A distal flap turned upward to the central end of the divided nerve deprives the distal segment of a large number of its conducting pathways. A glance at the diagrammatic representation of these operations makes it obvious that the central downgrowing neuraxes would have to bridge the angle of attachment of the flap to its peripheral stump before they might eventually reach the terminations of the distal segment. Huber's experiments have definitely confirmed the many objections raised against this procedure. (Fig. 106.)

## SUTURE Á DISTANCE

In 1886, Assaky suggested that the gap between the ends of a severed nerve be bridged by strands of catgut. This method is based on the fact that the downgrowing neuraxes from the



FIG. 107. Suture á distance method of repair.

central stump meet with considerable resistance and are diverted from their course by connective tissue. Huber continued with experiments based upon this idea with the hope that the connective tissue which replaces the catgut upon absorption would constitute lesser paths of resistance along which the new axons might descend. Bundles of course catgut were tightly entwined with finer catgut threads, the ends of which were kept long enough to serve as sutures. After sterilization these bundles of catgut were sutured between the divided nerve ends. Huber obtained histologic and physiologic success in two instances.

This method furnishes a rather hazardous scaffolding of the downgrowth of neuraxes which depends for success upon the rapidity of growth and the density of scar tissue formation. While it is of more academic than surgical interest it cannot be completely condemned, from an experimental viewpoint (Fig. 107).

## TUBULAR SUTURE

Tubular suture is a method of repair which was used early in the development of the surgical treatment of nerve defects. It is obviously an extension of Assaky's idea of bridging a nerve defect in such a way as to supply aid to the central neuraxes in their efforts to grow downward into the distal segment. Strictly speaking, a tubular suture means the introduction of the central and distal ends of the divided nerve into a tubular structure which may be empty or filled. This must be

kept distinct from the procedure of wrapping the line of nerve suture, or a transplant, or a nerve trunk after neurolysis, with a membrane or other substance to prevent the ingrowth of scar tissue.

In 1881, Gluck inserted the nerve ends into a bone drain without obtaining evidence of regeneration. Vanlair also performed experiments with bone drains and in one dog, four months after operation, he found many nerve fibers in the tissue which connected the nerve ends.

Many other substances have been used in an attempt to find an ideal method for tubular sutures. Wölfler used tubes made of iodoform gauze; Steinthal, rubber tubes which were both empty and filled with serum; Payr, magnesium tubes; Meuriot and Platon, rubber bandages; Auerbach, galalith tubes which consist of formalinized casein; Lotheisen, hardened gelatin tubes; Kirk and Lewis, fascial tubes; Perthes, tubes made from free transplants of fatty tissue; Foramitti, formalin hardened arteries; and Edinger, arteries filled with agar or blood serum. The majority of these methods are of more academic than practical surgical interest but, unfortunately, many have been used in spite of the fact that direct end-to-end suture was possible. The method of Edinger, for example, was used extensively during the Great War. The basis for the use of agar or serum filled vessels was that since neuraxes grow in a tissue culture of agar or blood serum, a tubular suture of such material should be a distinct benefit. Hohman and Spielmeyer tested the tubes on experimental animals and found that agar blocked the growth of the neuraxes. Blood serum, lecithin, brain pulp and other substances were used but the experimental and clinical results of a large number of investigators including Stracker, Enderlen and Lohenhoffer, Spitzzy, Eden, Blencke, Wollenberg, Bethe, Bielschowsky and Unger, Struck and others failed to lend support to this method. Kirk and Lewis on the other hand concluded that neuraxes from the central end would grow through a fascial tube and that a defect could be bridged successfully in this manner. Their

experiments were controlled very carefully by histological studies. They stated that axis cylinders develop first and most rapidly along the side of the tube so that the central nerve end

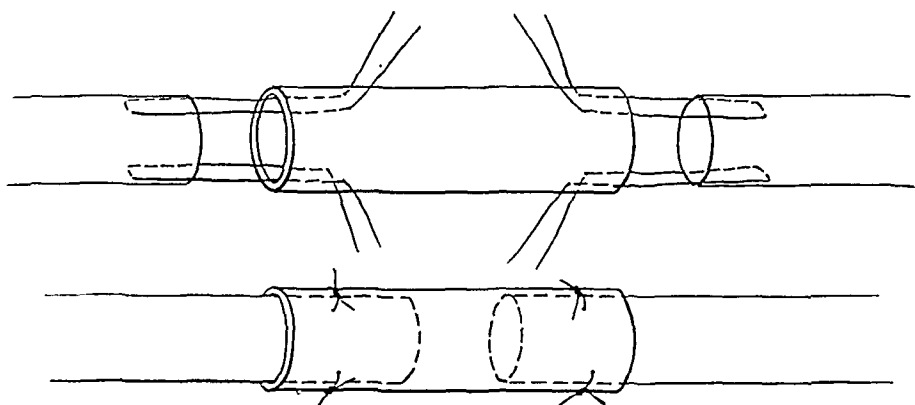


FIG. 108. Tubular suture of a divided nerve.

becomes oblique in appearance. After four weeks, in the case of a defect of 1 cm. or less, the gap is filled with a firm, pearly white mass which has longitudinal striations. If the defect is larger a part of the tube may be seen to be filled with a substance softer than the nerve and dark grey in color which does not contain axis cylinders. It is stated that in passing through the tube the axis cylinders do not remain in bundles because of the more rapid advance of some fibers. Later they become arranged in bundles similar to those in the normal nerve. (Fig. 108.)

Huber performed a series of experiments based upon Foranmitti's suggestion for the use of formalin hardened arteries. He found that such tubes remained unabsorbed for eight months which is long enough for neuraxes to reach the distal stump. Distinct neuromas were found on the distal end of the central stump and within the arterial tube. Connective tissue which seemed to have originated from the nerve ends and not from the surrounding tissue was found within the lumen of the tubular suture. Huber obtained physiologic and

histologic evidence of regeneration in an experiment of two hundred and forty days' duration in which a gap of 3 cm. was bridged.

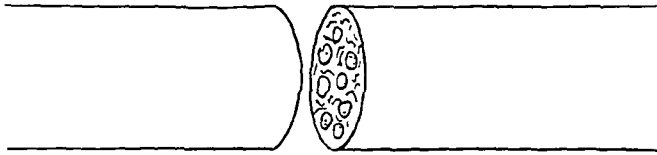


FIG. 109. Method of end-to-end suture of a divided nerve.

### END-TO-END SUTURE

The method of repair of choice is end-to-end suture of the separated nerve ends. The experimental and clinical results which have been obtained with this method far surpass any other suggested means of obtaining a downgrowth of central neuraxes. Because of this fact it becomes increasingly important to make every effort to obtain this approximation of the nerve ends. The problem is, of course, quite simple in a fresh wound without any loss of nerve substance. However, the difficulties encountered when extensive neuromas must be resected from each end to reach normal tissue, or when a large gap must be bridged, are considerably harder. The methods employed to obtain end-to-end apposition, such as mobilization of the nerve, transposition of the nerve trunk from its normal course, and nerve stretching will be described in the chapter which deals with the surgical technique of end-to-end suture (Fig. 109).

In summary we may say that in clinical practice end-to-end suture is the method of repair of first choice. Further, that nerve crossing and nerve transplants are the methods by which the next most successful results may be obtained. Finally, that nerve flaps, nerve implantation, tubular sutures and suture *à distance* are methods which may be discarded because of the poor clinical results which are obtained. In the event that end-to-end suture, nerve crossing or transplants are impossible



it is more than likely that the nerve lesion should be classed as irreparable and that the methods of treatment described for irreparable nerve defects should be employed.

## ERRATUM

The legends for Figures 39-45, which appeared in the February installment of "Peripheral Nerve Injuries," Vol. xv, pages 418-421, should have read as follows:

FIG. 39. Residual sensibility to pin prick of the ulnar nerve.

FIG. 40. Residual sensibility to pin prick of the median nerve.

FIG. 41. Residual sensibility to pin prick of the radial nerve.

FIG. 42. Residual sensibility to pin prick of the musculocutaneous nerve.

FIG. 43. Residual sensibility to pin prick of the peroneal nerve.

FIG. 44. Residual sensibility to pin prick of the tibial nerve.

FIG. 45. Residual sensibility to pin prick of the saphenous nerve.

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## DIFFERENTIAL DIAGNOSIS OF LESIONS IN & ADJACENT TO THE SELLA TURCICA\*

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PHILADELPHIA

IN our files in the Neurosurgical Clinic of the University Hospital are 368 cases originating in the pituitary body and structures immediately adjacent. In the early days of the surgery of pituitary lesions we were wont to think mostly of the intrasellar adenoma, representing as it does unquestionably the most frequent of all lesions in this territory. As time progressed our attention was drawn to many other tumors which, because of their juxtaposition to the sella turcica gave rise to endocrine symptoms of pituitary origin and to structural changes in the bony processes of the pituitary fossa.

The most satisfactory classification of the lesions under consideration is based upon the pathological histology of the lesion in question. Upon this basis we will include in our discussion of the differential diagnosis supported by illustrative cases, the following:

- I. Intrasellar adenoma
- II. Suprasellar adenoma
- III. Adenocarcinoma
- IV. Malignant adenoma
- V. Adamantinoma
- VI. Teratoma
- VII. Ganglioneuroma
- VIII. Suprasellar arachnitis (pseudotumor).
- IX. Suprasellar fibroblastoma.

### I. INTRASELLAR ADENOMA

Speaking first of the intrasellar adenomata, we have observed an extraordinary variation in the clinical syndrome and the cases naturally group themselves into subdivisions: (1) those with outstanding endocrine symptoms but without visual disturbances; (2) those conspicuous for their field distortions and loss of visual acuity with little if any evidence of endocrine disorders, and (3) those in which both visual disorders and endocrine dysfunction are equally represented. The majority of patients are over thirty years of age, a small minority have intense headache of the pituitary type, in some there is the picture of acromegaly, in others of the Fröhlich syndrome or perhaps a combination of the two. With occasional exceptions as in the suprasellar type there is the unfailing ballooning of the sella turcica, an unmistakable expansion of the sella in both vertical and anteroposterior diameters at the expense of the sphenoid sinus. The roentgenogram of the primary pituitary lesion admits of but one interpretation and, with notable exceptions, the diagnosis of an intrasellar adenoma may be made upon the roentgenogram alone. When the vertical diameter is decidedly

\* From the Neurosurgical Clinic of the University Hospital, Philadelphia, Pa. Submitted for publication February 2, 1932.

increased as it should be a line drawn from the tip of the ear to the nasal spine always passes through the plane of the sellar

was thirty-four, 40 per cent were females and 60 per cent males. In 75 per cent there was a bitemporal hemianopsia, in 10 per

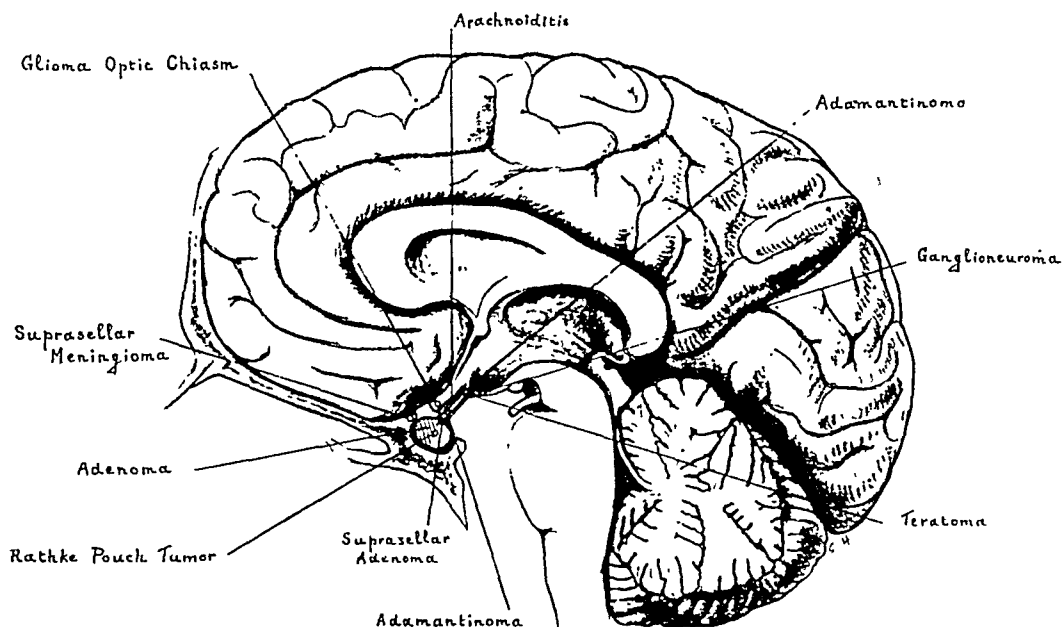


FIG. 1. Diagrammatic sketch showing position of various types of lesions in and about optic chiasm.

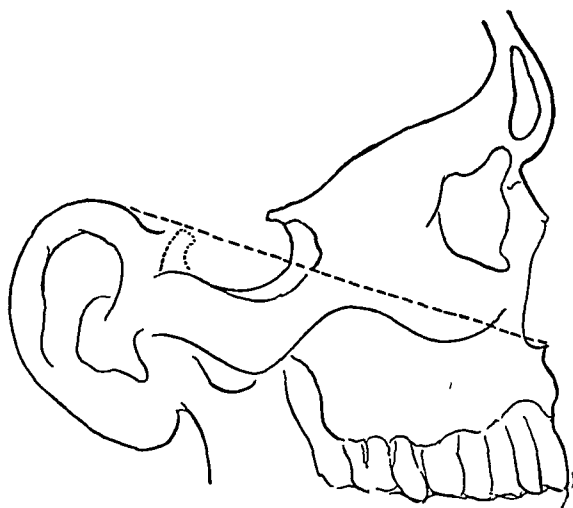


FIG. 2. Diagrammatic sketch to illustrate relation of line drawn from nasal spine to tip of ear. When vertical diameter of pituitary fossa is increased as in pituitary adenomata this line passes through fossa.

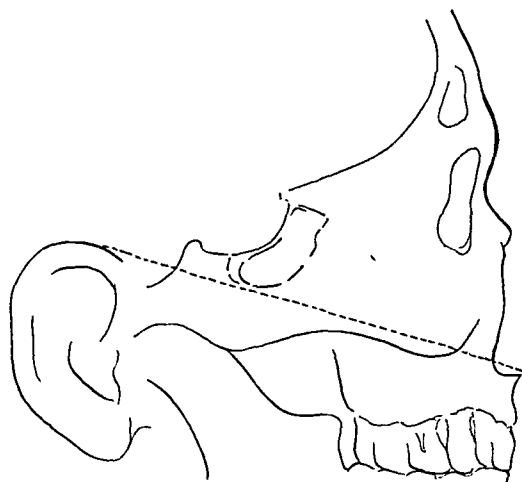


FIG. 3. Diagrammatic sketch to illustrate relation of line drawn from nasal spine to tip of ear. When vertical diameter of pituitary fossa is not increased this line passes below fossa.

floor. (Fig. 2.) When the vertical diameter is not increased appreciably this projected line will pass below the sellar floor. (Fig. 3.) In our series of primary pituitary adenomata, intrasellar, the average age

cent an homonymous hemianopsia, 12 per cent were already blind in one eye.

*Case 1. Summary.* A typical case of pituitary adenoma in a male subject twenty-five years of age, operated upon by

the transphenoidal route; seven years after the operation the patient is symptom free and fields are full.

sphenoid sinus opened and found to be more capacious than is usually the case in pituitary operations. Sellar floor was about twice as

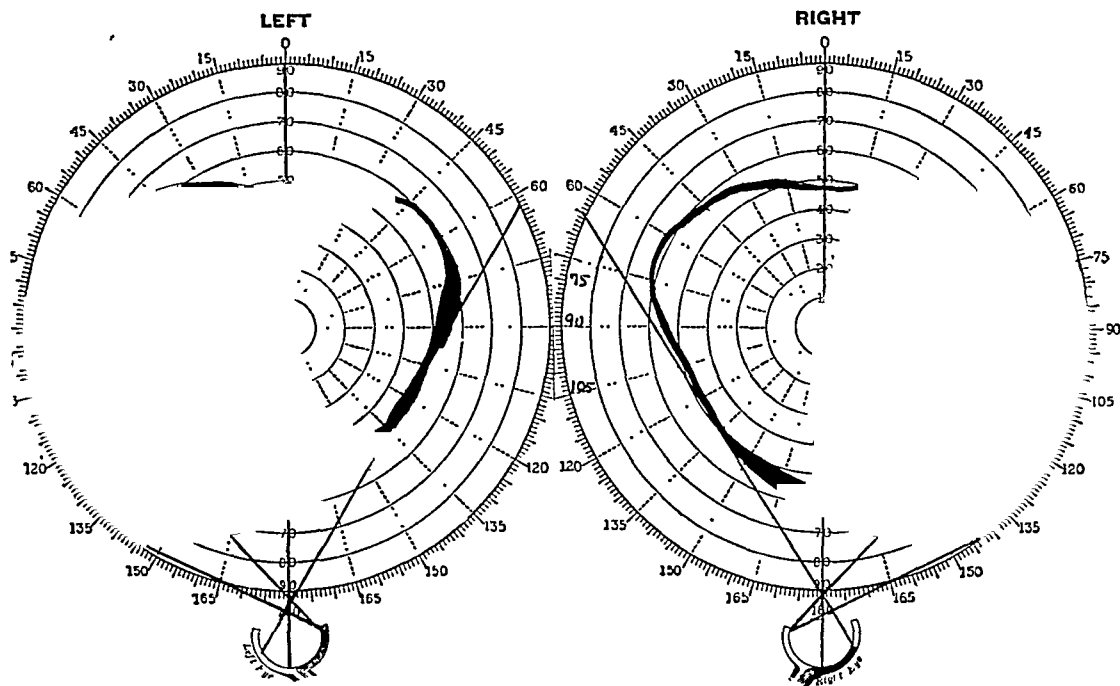


FIG. 4. Case 1. Fields before operations.

**CASE 1.** O. G. L. a male, aet. twenty-eight years, File No. 2279 N. S. was referred by Dr. G. E. deSchweinitz to the Neurosurgical Service of the University Hospital October 27, 1923, complaining chiefly of headache and failing vision.

*History.* Two years ago, 1921, began to have terrific frontal headaches about once a week. June 1922 and on several occasions afterward, he had diplopia. He has complained lately of polyuria and polydipsia and lately has gained 20 pounds in weight.

*Examination.* There were no unusual findings except those which related to the pituitary lesion.

*Endocrine Disturbances.* Polydipsia, polyuria, basal metabolism minus 30, accession in weight, impotence.

*Ocular Disturbances.* Bitemporal hemianopsia, vision O. D. 4/15 O. S. 4/12. (Fig. 4.)

*Pressure Phenomena.* Violent headache.

*Roentgenogram.* Sella turcica 15 × 17 mm. (Fig. 5.)

*Operation.* Transphenoidal hypophysectomy November 6, 1923. By the usual technique the nasal septum was resected, the



FIG. 5. Case 1. Deformation of sella, moderate enlargement, measurements A.P. 15 mm. depth 17 mm.

thick as an egg shell. After its penetration and removal the capsule was split and soft gelatinous material was evacuated with a curet,

the cavity was swabbed with 3 per cent iodine solution, the operation discontinued and the wound closed. (Fig. 6.)



FIG. 6. Case 1. Incision now used for transfrontal craniotomy, beginning 1 inch below hair line of forehead, extending posteriorly to just above ear.

Fourteen days after operation the patient's fields were practically normal. (Fig. 7.)

*Pathological Diagnosis.* Adenoma.

*Postoperative Notes.* The patient has been followed from time to time. When last seen in October, 1930, seven years after his operation, there was no evidence of recurrence.

## II. SUPRASELLAR ADENOMA

As exceptions to the characteristic features of the primary adenomata, mention should be made of the suprasellar adenomata. (Fig. 8.) They may differ in no respects from the primary intrasellar adenomata other than in the absence of the characteristic ballooning of the sella. The field distortion is the same, bitemporal hemianopsia, and, they may, as in the case to be cited, or they may not exhibit endocrine disturbances. The extension up-

ward rather than downward of the growth may be due to an unusually large foramen or to very loose texture of the diaphragma sellae. While the sella may not be deepened, the dorsum sella may be eroded and even as in our case, disappear. In this respect they resemble the suprasellar fibroblastomata. The latter as a rule occur at a later period than the adenomata. (Fig. 9.)

*Case 11. Summary.* A suprasellar adenoma in a middle-aged physician, without endocrine disturbance, without deepening of the sella, with a bitemporal hemianopsia and visual hallucinations, is actively engaged in his profession four years after the operation. (Fig. 10.)

*CASE 11.* W. J. K. aet. forty-eight years, File No. 4544 N.S. was admitted to the Neurosurgical Service of the University Hospital November 22, 1924, complaining chiefly of failing vision.

*History.* Being a sportsman and fond of shooting, the patient noticed for the past five years his eye sight was failing. He had had his tonsils and one tooth removed and his sinuses x-rayed, hoping to remove any septic focus. For the past six months his vision rapidly deteriorated and he noticed he could not see objects in his temporal fields. For the past three months he has not been able to read fine print. There is some diplopia for distant vision and occasionally on the right side he sees white flashes of light. As a physician he has continued his practice up to the present time.

*Examination.* A thorough physical and neurological examination revealed no abnormalities relating to the pituitary body. He had not gained weight, he had no headache, there were no suggestions of acromegaly nor of any endocrine disturbance.

*Ocular Disturbances.* There was a bitemporal hemianopsia.

*Roentgenogram.* There was no depression of the floor of the sella but the dorsum sella had practically disappeared. (Fig. 11.)

*Operation.* Transfrontal craniotomy, right. Local anesthesia. Elevation of frontal lobe under the protection of cotton tampons. The right optic nerve was carefully isolated from the capsule, the capsule opened and its contents removed. The contents were partly

solid and partly fluid and when removed all signs of pressure had disappeared.

*Pathological Diagnosis.* Adenoma.

is in the proportion of 7 to 1. As there are many other clinically classified adenomata without pathological identification, this

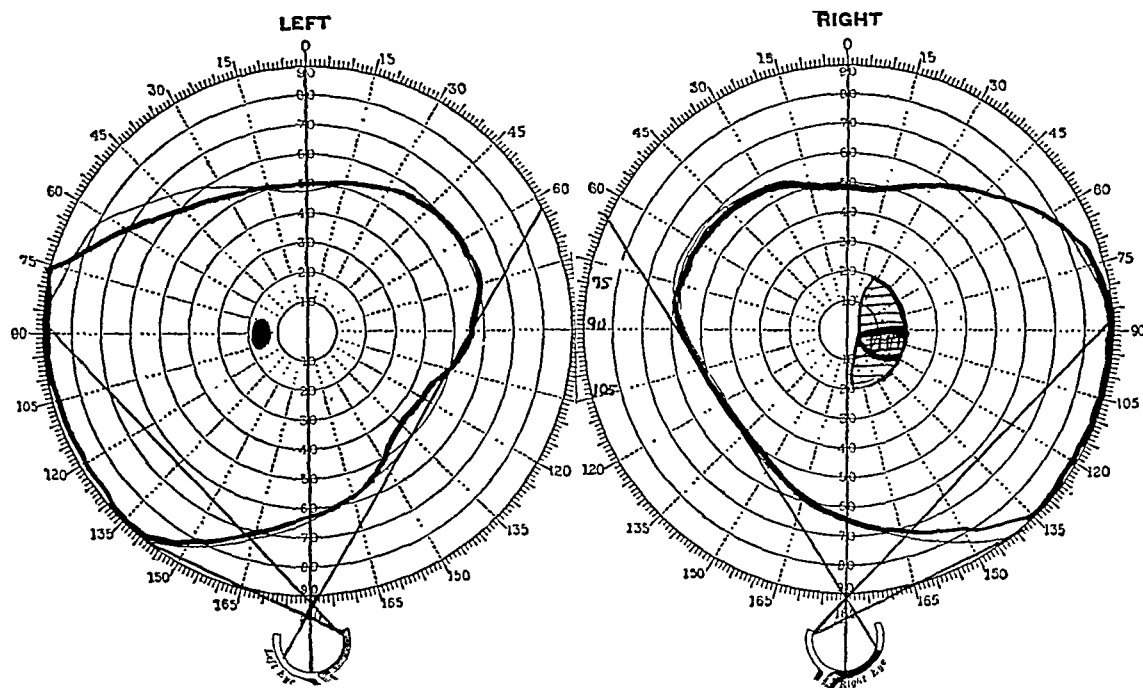


FIG. 7. Case 1. Fields after operation.



FIG. 8. Photograph of suprasellar adenoma.

*Postoperative Note.* The patient was discharged December 28, 1924 and was last heard from January 13, 1932, eight years after the operation when he wrote: "I am very well, working every day and have not suffered any inconvenience since the operation."

### III. ADENOCARCINOMA

Included among the tumors which at some stage present the characteristics of an intrasellar tumor are the adenocarcinomata. In my series of verified adenomata and adenocarcinomata the incidence

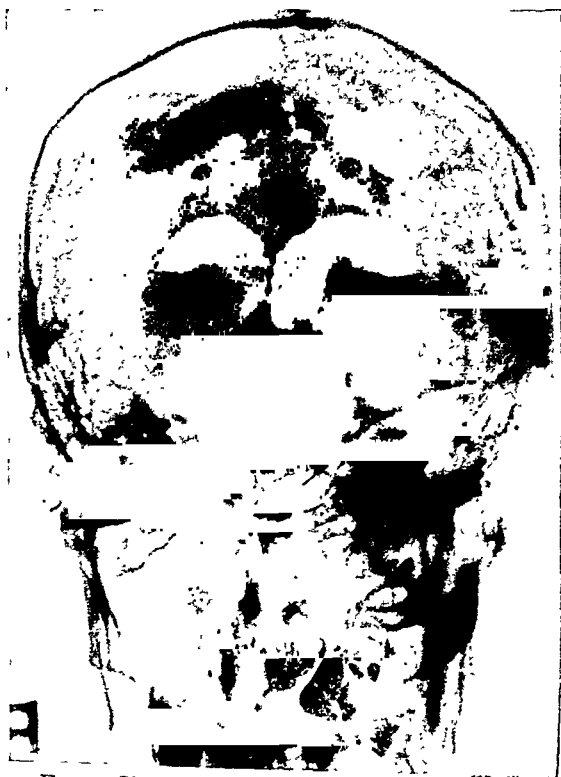


FIG. 9. Size and position of suprasellar adenoma.



proportion appears relatively large. It is in the early stage of the adenocarcinoma that confusion in diagnosis may readily

months ago he noticed he could not see objects on either side without turning his head. Three months ago he could read only large type. He

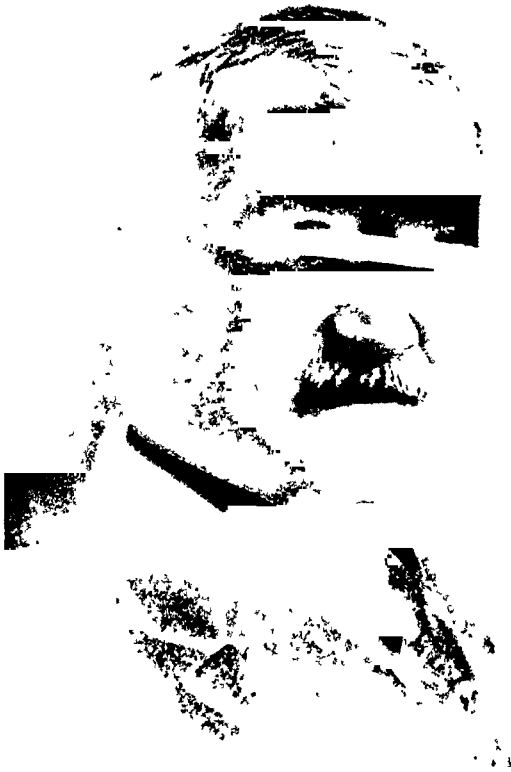


FIG. 10. Case 11. Photograph of patient.

arise; originating as it does in the anterior lobe, the tumor may present all the earmarks of the benign adenoma. Illustrative of this stage is the following case:

**Case 111. Summary.** An intrasellar growth in a male of middle life, with failing vision, hemianopsia, primary optic atrophy and headaches. Pressure temporarily relieved by evacuation of the sellar contents by the transphenoidal route. The tumor proved to be an adenocarcinoma.

**CASE 111. V. M.** male, aet. forty-nine years, File No. 65176, was admitted to the Neurosurgical Service of the University Hospital July 15, 1921, complaining of dimness of vision.

**History.** Three years ago the left eye was injured in an accident. His vision in this eye was somewhat damaged but a year and a half later it was noticed that the sight in both eyes was affected and progressively failing. Six



FIG. 11. Case 11. Complete atrophy of dorsum sellae without depression of sellar floor or encroachment on sphenoid sinus.

had occasional headaches and occasional attacks of vertigo.

**Examination.** The patient was somewhat emaciated but in other respects with the exception of vision there was no evidence of any physical disability.

**Endocrine Disturbances.** None.

**Ocular Disturbances.** Vision O.D. 5/10, O. S. 5/20. Optic nerves pale with shallow atrophic excavation. Fields showed a bitemporal hemianopsia. (Fig. 12.)

**Roentgenogram.** Pituitary growth. Measurements A. P. 13 mm. depth 10 mm. (Fig. 13.)

**Blood Sugar.** Before administration of 100 gm. glucose .067, one hour afterward .265, two hours .092, three hours .060.

**Operation.** Transphenoidal hypophysectomy, July 20, 1921. Ether anesthesia. The floor of the sella was still intact although so thin that it could readily be penetrated with the sharp end of the probe. When the floor was removed the capsule of the tumor was exposed. Upon incision of the capsule hemorrhage was profuse, the tumor was extremely vascular. The contents were removed with curet and forceps. The operation was uncomplicated. The wound was closed with deep and superficial sutures and the nares tamponed.

*Pathological Diagnosis.* Adenocarcinoma.

*Postoperative Note.* The patient recovered from the immediate effects of the operation

CASE IV. A. B. male, aet. forty-seven years, File No. 17294, was admitted to the Neurosurgical Service of the University Hos-

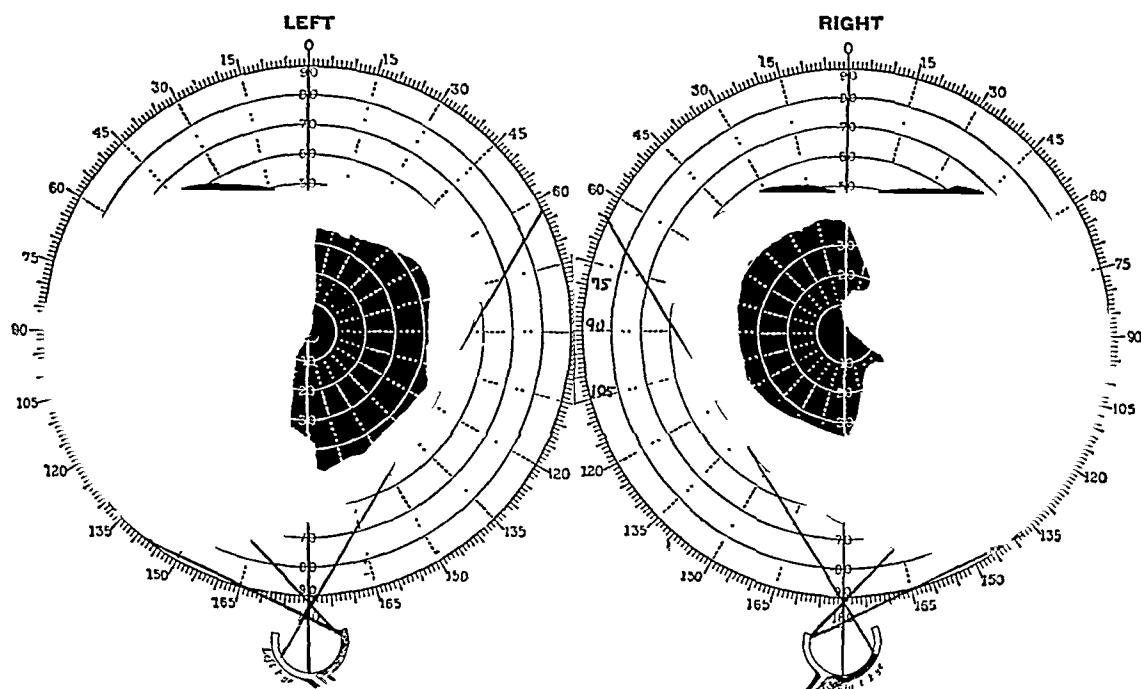


FIG. 12. Case III. Visual fields before operation.

but several months later gradually became more and more stuporous and died December 11, 1921. Permission was granted for the removal of the brain and the physical characteristics of the tumor and reproduced in the illustration. (Fig. 14.)

There was a moderate suprasellar extension of the growth, but en masse it was not much larger than the dimensions of some cases of benign adenomata. The cause of death was undetermined. Certainly there are other cases of adenocarcinomata attaining much larger proportions and still consistent with life.

If this case represents a comparatively early stage of the adenocarcinoma others might be cited to illustrate the tendency of these tumors to attain enormous proportions and spread far beyond the confines of the sella turcica. One of these will suffice as an illustration.

*Case IV. Summary.* An adenocarcinoma arising in the pituitary fossa with involvement of III, V, VI, VII, IX, X and XII cranial nerves; extension into the posterior ethmoid and sphenoid sinuses, left orbit, pharynx, nares and posterior fossa.



FIG. 13. Case III. Ballooning of sella turcica characteristic of pituitary adenomata.

pital October 29, 1929, complaining of left-sided facial pain, and diplopia.

*History.* Until five months ago the patient was perfectly well. May 28, 1927, he noticed diplopia on looking to the left. Four months

ago eight teeth were extracted. Soon after he complained of pain first in the mandibular, then in the maxillary and finally in the ophthal-

face is flattened, cannot chew on left side, although he wrinkles forehead on both sides. ix, Sensation on left side of pharynx impaired,

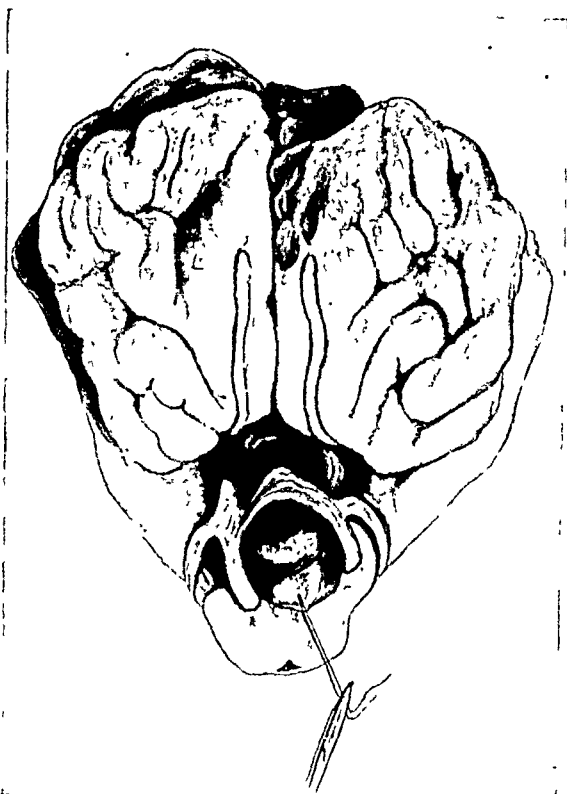


FIG. 14. Case III. Drawing of tumor showing relationship to optic chiasm and optic nerves.

mic division of the left trigeminus. The pain, which has increased in severity especially in the malar and temporal regions, is described as burning with knife-like exacerbations, a lightning hot pain. There is hyperesthesia in the left temporal region and below a sense of tingling. The left side of the face has been swollen, with weakness for the past four months.

**Examination.** A middle-aged man, who appears sick, is somewhat stuporous and difficult to arouse. There are no paralyses except of the face. The biceps, triceps, patellar and Achilles tendon reflexes are exaggerated on both sides. There is a positive ankle clonus on the right side.

**Cranial Nerves.** III, Drooping of the left eyelid. v, The jaw deviates to the left on opening the mouth. There is anesthetism to touch and paroxysmal pain in the left trigeminal distribution. (Fig. 15.) VI, Diplopia on looking to the left. VII, The left side of the

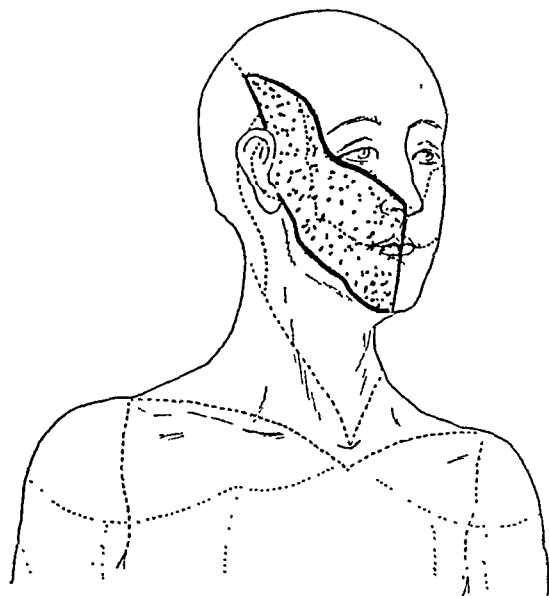


FIG. 15. Case IV. Chart showing area of sensory disturbance in trigeminal distribution.

difficulty in swallowing. x, Palatal and pharyngeal reflexes absent on left. XII, Protrudes tongue to left.

**Pharynx.** Examination of pharynx reveals a tumor somewhat resembling a pharyngeal tonsil. Presumably extension of tumor through basilar process of sphenoid sinus.

**Pituitary Stigmata.** Loss of libido.

**Ocular Phenomena.** Vision unimpaired. Discs, waxy yellow. Diplopia on looking to left, horizontal nystagmus on looking to right. Fields, normal. Vision O. D. and O.S. 20/20.

**Roentgenogram.** Evidence of destructive growth in pituitary fossa. Complete disappearance of dorsum sella. Clouding of sphenoid and posterior ethmoid sinuses. (Fig. 16.)

**Cerebrospinal Fluid.** Pressure 220 mm. Protein 3.5 units 52 lymphocytes.

**Operation.** Exploratory craniotomy and subtemporal decompression November 4, 1929. Ether anesthesia, colonic. An exploratory operation was contemplated but by the time the olfactory groove was seen the patient's condition was such that it did not seem wise to continue. Sufficient bone was removed from beneath the temporal muscle for decompressive purposes and the wound was closed.

During the convalescent period the pain in the trigeminal distribution was so intense an alcoholic injection was given. The patient

ethmoid sinuses, may send extensions into the middle fossa and in one of our series there was so large an extension in the

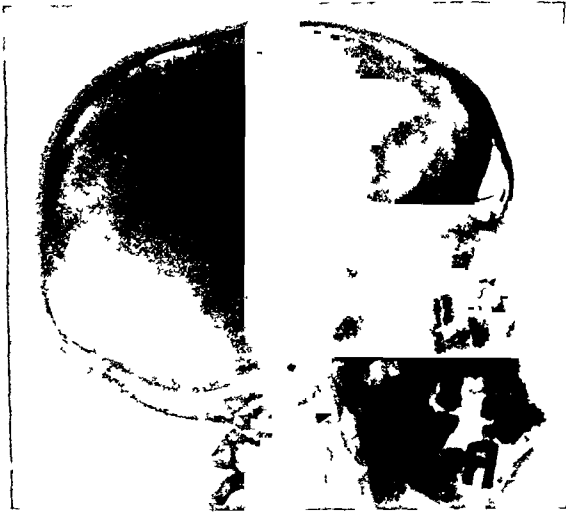


FIG. 16. Case IV. Evidence of destructive growth in pituitary fossa. Complete disappearance of dorsum sellae. Clouding of sphenoid and posterior ethmoid sinuses.

developed a corneal ulcer in the left eye. At times he was confused. He was given repeated doses of 50 per cent glucose. December 7, 1929, the patient could not swallow. December 10, 1929 he was at times stuporous, at times mentally confused. He was discharged from the hospital December 12, 1929.

The patient died soon after his return home. At the autopsy a large tumor was found arising in the pituitary body but extending in every direction. The cribriform plate and posterior ethmoid cells were practically destroyed. The central part of the sphenoid was entirely replaced with tumor. The central part of the tumor was composed of soft tissue but around the margins were tiny trabeculae of bone. The tumor was not sharply demarcated and could not be entirely removed. It had perforated the left orbit. There was an extension 3 cm. in length into the posterior fossa compressing the left cerebellar hemisphere. The tumor had invaded the pharynx and nares. (Fig. 17.)

This description of the invasion of structures far beyond the confines of the sella turcica might be said to be characteristic of the adenocarcinoma. The tumor invades adjacent sinuses, sphenoid and

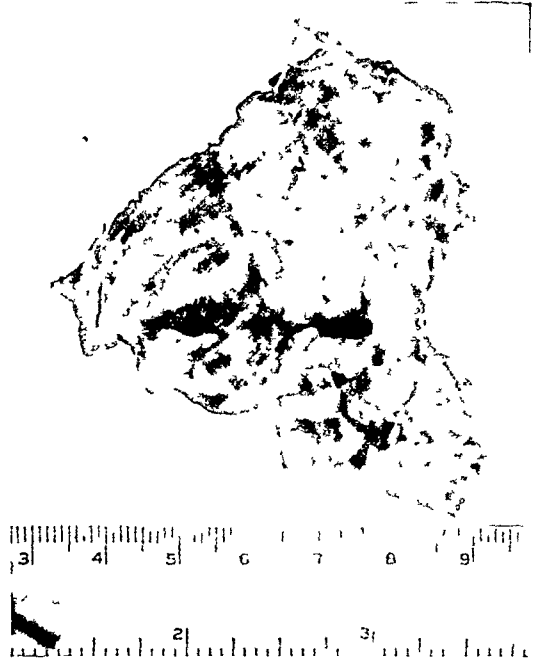


FIG. 17. Case IV. Photograph of tumor.

posterior fossa that the outstanding symptoms were those of cerebellar dysfunction. Unlike the benign adenomata the adenocarcinomata involve the cranial nerves that flank the sella turcica. Thus in the early stages hypesthesia in the trigeminal distribution and later pain or paralysis of the oculomotor or trochlear bespeak the tendency of the tumor to extend beyond the confines of the pituitary fossa. Possibly because of its destructive character, as it eats its way into the sinus or orbit, the tumor may attain large proportions without causing alarming signs of intracranial pressure. The erosive action of the tumor at the base of the skull, its infiltrating character, its lack of encapsulation possibly accounts for the fact that pressure is not exerted upon the third ventricle and the signs of a ventricular block, headache vomiting and papilledema may be conspicuous by their absence.

At all events the invasion of structures beyond the bounds of the pituitary fossa

is the striking characteristic of the adenocarcinoma. When, therefore, the roentgenogram reveals destruction of dorsum sellae,

left. She complains of an area of localized tenderness on the right side of the head from which her headaches radiate to the occiput.



FIG. 18. Case v. Pituitary fossa only moderately enlarged. A.P. measurement 15 mm. Stereoscopic view showing depth 9 mm. on left, 13 mm. on right side.



FIG. 19. Case v. Skull, showing erosion of floor of pituitary fossa.

clouding of the sinuses, perhaps erosion of the petrous bone, when there are signs of involvement of the third, fourth or fifth cranial nerves with or without signs of cerebellar disturbance, one may postulate with reasonable assurance an adenocarcinoma.

#### IV. MALIGNANT ADENOMA

*Case v. Summary.* A large malignant adenoma, mostly extrasellar, in a young woman with symptoms of only a few weeks' duration.

*CASE v.* M. T. female, aet. nineteen years, File No. 20497 was admitted to the Neurosurgical Service of the University Hospital October 18, 1930, complaining of headache, failure of vision and projectile vomiting.

*History.* September 10, 1930 only three weeks ago the patient began to complain of temporal headaches and projectile vomiting. One week later her vision began to fail and in another week her temporal fields were lost. At the present time she can see nothing with the right eye and objects at 5 inches with the

Two weeks ago she had vertigo and tinnitus aurium. She menstruated only once in her fourteenth year and never since then.

*Examination.* A stolid fat young woman of foreign birth; head broad with low forehead and high cheek bones. The patient is uncooperative and her attention poor. There is weakness of both the left upper and lower extremity and a left facial weakness of central origin. The left abdominal and patellar reflexes are exaggerated with a positive left Babinski.

*Pituitary Stigmata.* Amenorrhea of five years' duration. Some accession in weight. Obesity.

*Ocular Disturbances.* Vision O. D. blind. O.S. can count fingers at 5 inches on nasal side. Temporal hemianopsia. Optic atrophy appears of secondary type.

*Roentgenogram.* Pituitary fossa enlarged. A.P. 15 mm. depth 9 mm. on the left and 13 mm. on the right side. (Fig. 18.)

*Pressure Phenomena.* Frontal and bitemporal headaches with projectile vomiting. Secondary optic atrophy.

*Cerebrospinal Fluid.* Pressure normal.

*Operation.* Transfrontal craniotomy, right. October 30, 1930. Colonic anesthesia. Upon reflection of osteoplastic flap the tension of dura was not found abnormal. A ventricular tap recovered only a few drops of fluid. No hydrocephalus. The frontal lobe was elevated with difficulty. One saw first the right optic

nerve and adjacent portion of the chiasm tightly stretched and flattened out over the tumor. At best one could not see more than a

a bunch of grapes, was of a reddish color and encapsulated. It was joined to the tela choriodea and adherent to the tentorium cerebelli.

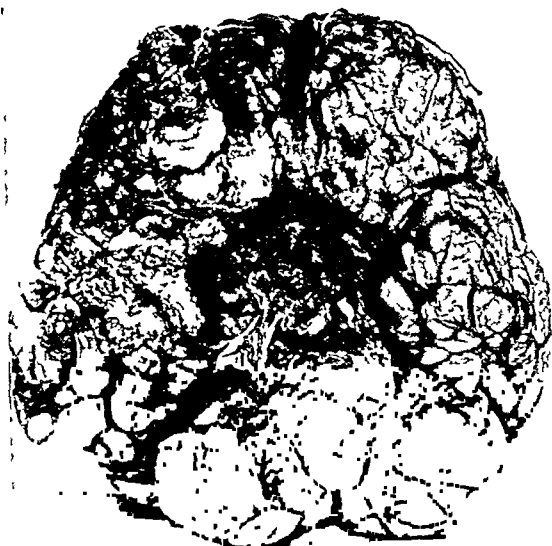


FIG. 20. Case v. Brain, showing malignant adenoma in situ.

small surface of the tumor, possibly a square centimeter. An aspirating needle failed to recover fluid. Any thought of dealing radically with the tumor had to be abandoned. A small section was removed for histological study.

We were of the impression that the tumor was mostly retrochiasmal, pushing the chiasm forward as a pharyngeal duct tumor. Throughout the operation the patient's condition was excellent, systolic pressure varied from 112-140, the pulse 80 to 120 and the respirations 18-20.

*Postoperative Note.* At 4 A.M. on the morning following the operation the temperature rose suddenly to 104°F. At 7 A.M. the lungs became edematous, at noon the patient died.

*Pathological Report.* At autopsy the brain was removed. The tumor measured 6.5 cm. long and 3.5 cm. wide, and 2.5 cm. thick. It filled the entire base of the brain from the olfactory gyrus to the pons. It was asymmetrical, longer on the right side on which side it encroached upon the cerebral structures. The tumor had excavated the base of the skull and perforated the right sphenoid sinus. (Fig. 19.) Both the right oculomotor and the right trochlear nerves were compressed. The tumor itself had a lobulated appearance, looked like

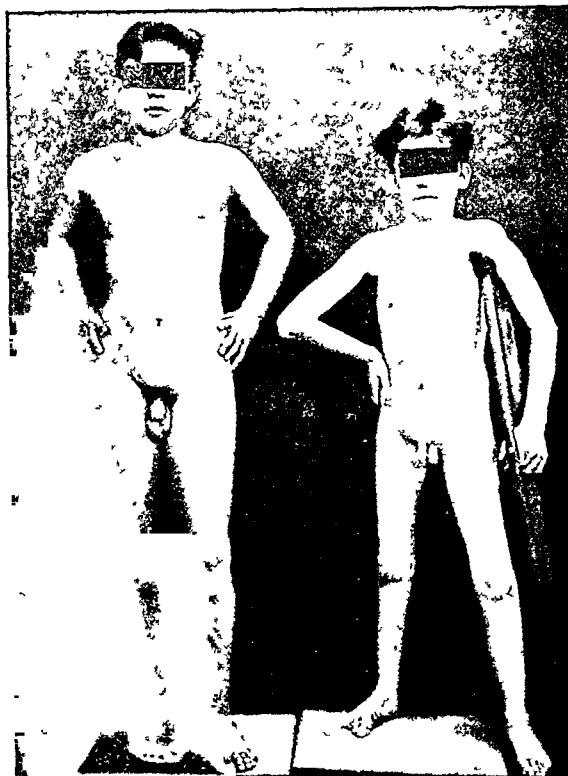


FIG. 21. Case vi. Patient fifteen years of age taken with average boy of twelve years, left.

It lay in a thick maze of blood vessels, some from the sylvian fissure, some from the base of the brain, some from the right occipital lobe. The vessels penetrating beneath the tumor were large and numerous.

On section the tumor was filled with blood. Fibrous septa divided the tumor into compartments. Small cysts were seen in the tumor mass. The pituitary itself could not be identified. On section the brain appeared markedly compressed at the base. There was marked distortion of the right side with resultant compression of the pallida and internal capsule of the right corpus mammillare and thalamus. The entire floor of the third ventricle was compressed and distorted. The right cerebral peduncle and pons also were compressed. Here the tumor was in direct connection with the tela choriodea of the inferior horn of the right lateral ventricle and seemed to form part of the capsule. (Fig. 20.)

Histologically the tumor appeared to be a malignant adenoma, largely extrasellar.

*Discussion.* From the standpoint of diagnosis this case presented many points of interest. The x-ray findings were most

above. It was evident that we were not dealing with a primary intrasellar adenoma and there was every reason to believe

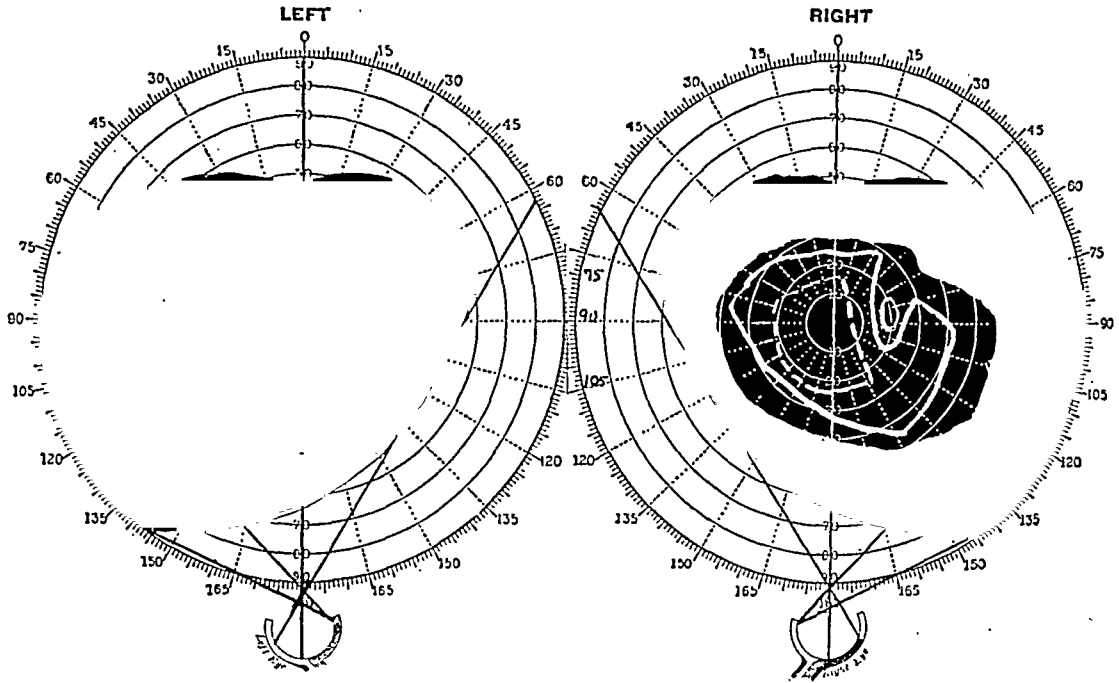


FIG. 22. Case vi. Visual fields before operation.



FIG. 23. Case vi. Roentgenogram showing pituitary fossa of enormous dimensions. A.P. measurement 23 mm. Vertical 19 mm.

unusual, in fact, quite unique in our pituitary series in that the sella turcica was asymmetrical with a depth on one side of 9 mm. and on the other of 13 mm. one below normal and the other but a little

because of the hemiparesis that the tumor had extended beyond the limits of the sella. Was it a pharyngeal duct tumor? The patient was young but there was no calcification.

The duration of the symptoms was a matter of surprise after the size of the tumor was revealed. To be sure the patient had amenorrhea for five years, which of course had to be taken into consideration, but the symptoms of pressure, hemianopsia, vomiting and headache were of less than a month's duration. Although the third ventricle was compressed we were surprised to find no evidence of hydrocephalus.

The signs of secondary optic atrophy suggested an earlier papilledema which had disappeared. What was the origin of the tumor? Did it arise from an extrasellar anlage or did it arise within the sella and escape through foramen of the diaphragm? Because of the absence of any trace of the pituitary body in the tumor mass, Dr. Alpers was inclined to accept the latter

interpretation. Had the mass arisen outside the sella in the infundibular stalk, one would have expected to find a compressed

incidental to the manouevers of the operation.

The pulmonary complications may be



FIG. 24. Case VI. Photograph of patient after operation showing incision formerly used for transfrontal operations and since abandoned. (See Fig. 6. Case I.)

pituitary gland. The presence of a ganglion within the tumor mass suggested extrasellar origin. It may have arisen from the pharyngeal hypophysis and involved the sphenopalatine ganglion in its course.

Extrasellar tumors which invade the interpeduncular space are well known to give rise to motor symptoms. In this case, however, the hemiparesis was readily explained by the marked compression of the structure in the right hemisphere, including the internal capsule, the pallidum, the corpus mamillare and the thalamus.

Within eighteen hours the patient developed hypothermia, pulmonary edema and died. There is no doubt a heat-regulating center in the infundibulo-tuberian region and the hypothermia which occasionally and as in this case, follow operations may be easily accounted for by trauma in the region of this heat center



FIG. 25. Case VII. Photograph of patient.

accounted for in this case by the marked evidence of a foraminal hernia.

The tumor in this case was manifestly inoperable. One must recognize in this zone certain insuperable obstacles and these are particularly encountered in the extrasellar and especially in the pharyngeal duct tumors.



## V. ADAMANTINOMA

Of the various types of tumors which enter into discussion, in the diagnosis of



FIG. 26. Case VII. Sella turcica of normal dimensions.

pituitary lesions, we must include the adamantinoma. It must be remembered

structure and these epithelial rests may be found low down in close relation with the anterior lobe of the pituitary body or higher in juxtaposition to the third ventricle. The different pictures that may be revealed according to whether the tumor originates in one or the other of these anlage are quite obvious. The identification of the tumor before the operation may present many difficulties in fact may be wholly impossible. There may be variations in the location of the lesion from the third ventricle above to the pituitary fossa below. There are extreme variations in the field distortions, there is wide discrepancy in the age of the patient from early childhood to middle age. In some cases the duration of symptoms may be a matter of months, in others a matter of years. It is said that these tumors predominate in children and young adolescents, but as a matter of fact in a series of 14 cases reported from our Clinic,<sup>1</sup> 2 were in the

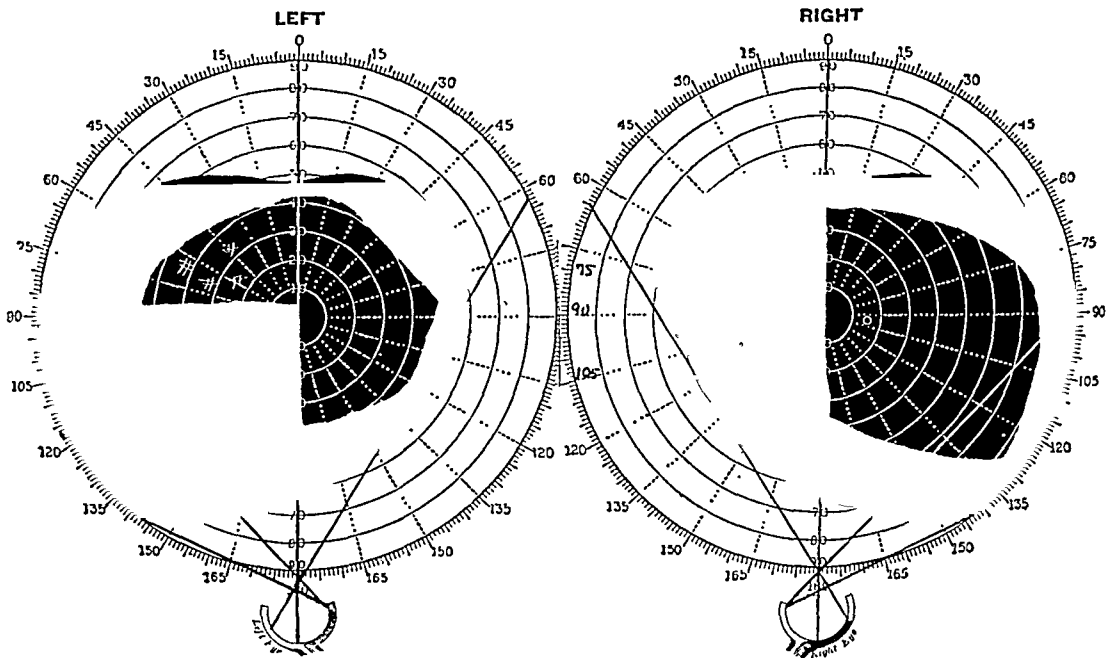


FIG. 27. Case VII. Fields: left homonymous hemianopsia which developed late in course of illness.

that these tumors arise from embryonal epithelial rests of which there are two. The craniopharyngeal duct is an embryonal

third decade, 2 in the fourth and one in the fifth.

<sup>1</sup> *Arch. Neurol. & Psychiat.*, 26: 905, 1931.

The endocrine picture in this series was uniform in this respect that neither acromegaly nor gigantism were represented.

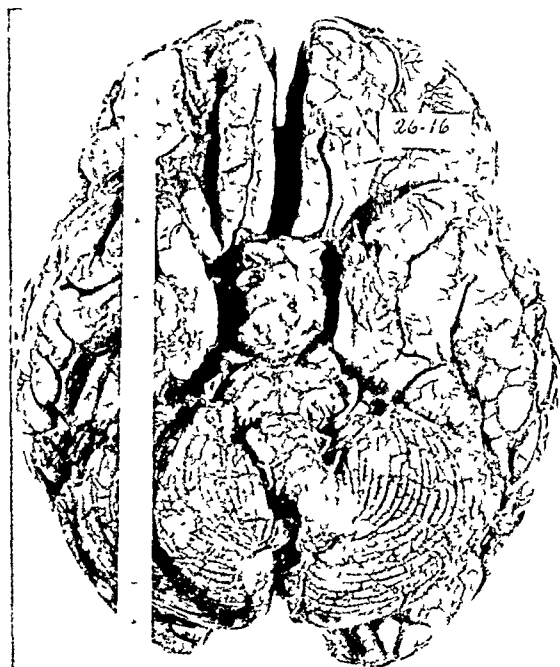


FIG. 28. Case VII. Base of brain showing retrochiasmal adamantinoma.

Dwarfism, somnolence, adiposity, regressive sex characteristics, femininity and polyuria predominated. As one might expect arrest of growth is the commonest endocrine disturbance.

The fact that the metabolic rate was, when recorded, always minus is of no diagnostic significance since in by far the majority of intrasellar adenomata the metabolic rate is below normal.

Increased intracranial pressure, when it implies obstruction of the third and lateral ventricles, is an important diagnostic feature as differentiating the primary pituitary adenomata from the pharyngeal duct lesions, such as the adamantinomata. Headache and vomiting, papilloedema and secondary optic atrophy, though present in only half of our series of adamantinoma, are never observed in the purely intrasellar adenomata.

As illustrating the extreme variations in the clinical picture of the adamantinomata

the following cases are presented in abstract.

*Case VI. Summary.* A fifteen year-old

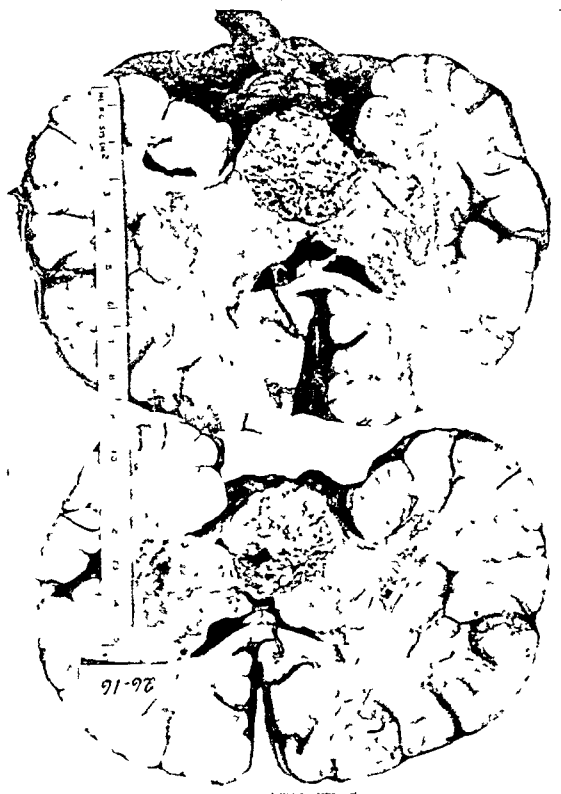


FIG. 29. Case VII. Cross section of brain showing an adamantinoma of pharyngeal duct, retrochiasmal.

boy, stunted in growth, blind in one eye with barrel vision in the other and signs of pituitary dysfunction is found to have a large cystic duct tumor. Tumor removed and patient survives the operation twenty months.

*CASE VI.* L. F. male, aet. fifteen years, File No. 14909 was admitted to the Neurosurgical Service of the University Hospital Nov. 9, 1928.

*History.* In the spring of the year 1928 his vision began to fail. At the time of admission the vision of the left eye was practically lost, and in the right eye vision was beginning to be affected. He had had occasional frontal and occipital headaches, at times severe, but there were no other subjective complaints.

*Examination.* Residual paralysis of the lower extremities (infantile paralysis).

*Pituitary Stigmata.* Dwarfism. Delayed development of external sexual characteristics. Basal metabolism minus 15. (Fig. 21.)

discs. Fields O. S. blind. O. D. concentric contraction. Barrel vision. (Fig. 22.)

*Roentgenogram.* Marked enlargement of the

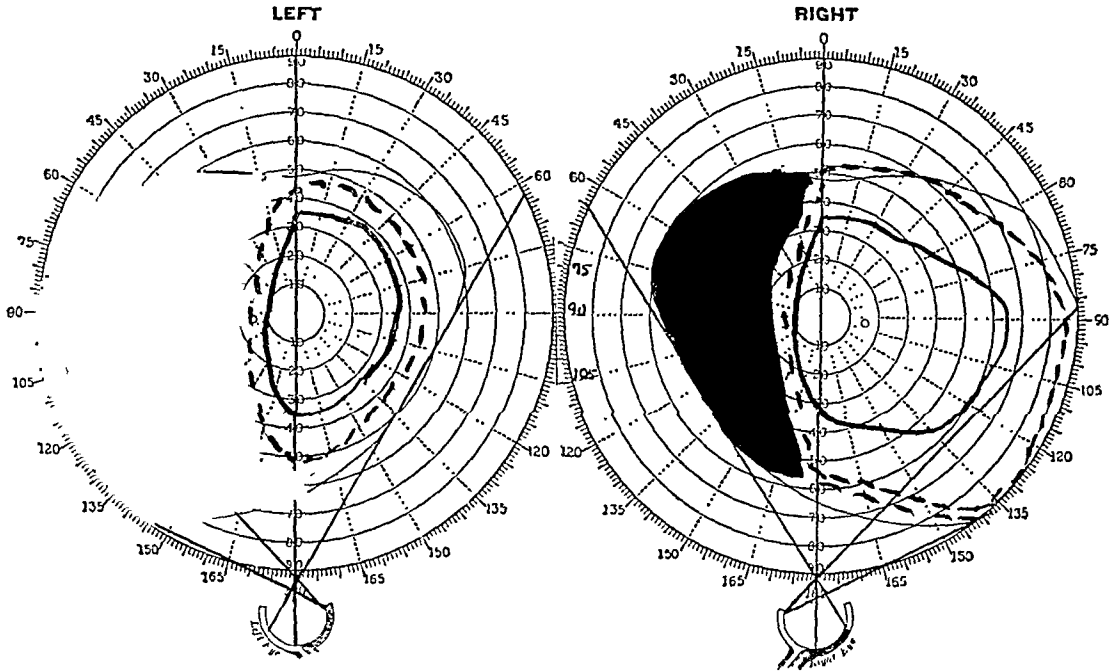


FIG. 30. Case VIII. Left homonymous hemianopsia.

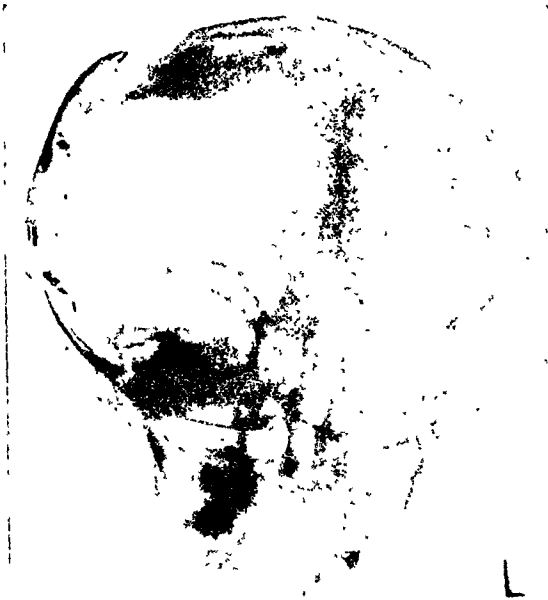


FIG. 31. Case VIII. A.P. view showing shadow of cyst filled with air.



FIG. 32. Case VIII. Suprasellar teratoma.

pituitary fossa, vertical 19 mm. anteroposterior 23 mm. Pansinusitis, except sphenoid sinus. (Fig. 23.)

*Operation.* Transfrontal craniotomy, right, Nov. 9, 1928. Because of the manifest enlargement of the pituitary fossa, the arrest of growth and sexual development of the patient and his age, a preoperative diagnosis of pharyngeal duct tumor was made.

A flap was reflected on the right side because the patient was blind in the left eye and there was hope only of restoring vision in the right eye. The dura was moderately tense, but an

*Ocular Manifestations.* O. S. blind. O. D. light perception. Grayish discoloration of both

attempt to tap the anterior horn of the ventricle failed. A horizontal incision was made in the dura and the frontal lobe elevated fol-

scissors, a considerable portion of the capsule on the right side was removed. The lesion was so extensive that that portion adjacent to the

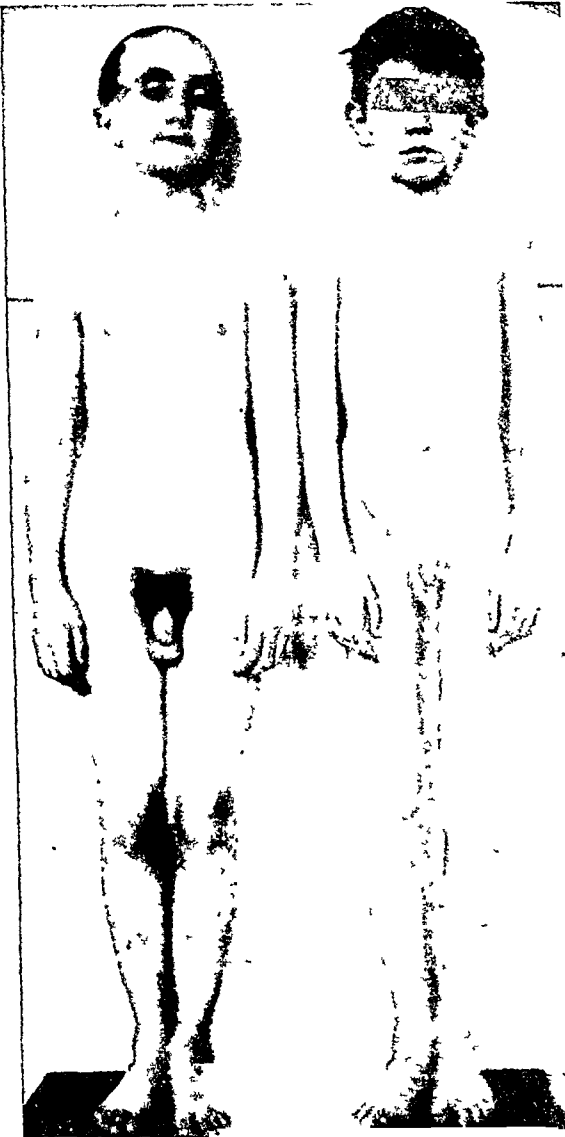


FIG. 33. Case VIII. Patient, left, taken beside boy of his own age, showing sexual precocity.

lowing the line of the greater wing of the sphenoid bone. Soon the lesion of large dimensions was seen presenting in front of the chiasm. (Fig. 24.)

The lesion proved to be chiefly cystic and with an aspirating syringe 17 c.c. of a yellowish red crystal laden fluid was evacuated. The capsule then collapsed, was incised and a large amount of solid tissue was removed with a curet. With a pair of long handled curved



FIG. 34. Case VIII. Note area of calcification over pituitary fossa.

left optic nerve could not be readily exposed. When the operation was concluded the right optic nerve was entirely free and a cavity the size of an English walnut remained. Hemostasis was effected with tampons of adrenalin, the cavity swabbed with iodine and the wound closed without drainage.

*Postoperative Note.* The convalescence was uneventful. A week after the operation the patient could count fingers with the right eye and on the ninth day his vision in that eye was 6/9 (before the operation only light perception). The fields had widened considerably. Nov. 28, 1928, nineteen days after operation, the patient was discharged.

*Subsequent Notes.* In the course of the next two years the patient was seen from time to time. Signs of pressure recurred, the patient became somnolent, gained 10 pounds in weight, had attacks of headache and vomiting, the metabolic rate was minus 46. He died July 8, 1930, twenty months after the transfrontal craniotomy.

Judging from the sellar deformation one might presume an intrasellar adenoma. There was the characteristic ballooning of the sella, the sphenoid sinus was obliterated, the dorsum sella intact. To account for this the tumor must have taken its origin from the lower of the two epithelial rests in

the craniopharyngeal duct. There was no calcification. On the other hand, the patient was an adolescent only fifteen years old, his

all respects, save in the age of the patient, the clinical characteristics were not unlike those of an intrasellar adenoma.

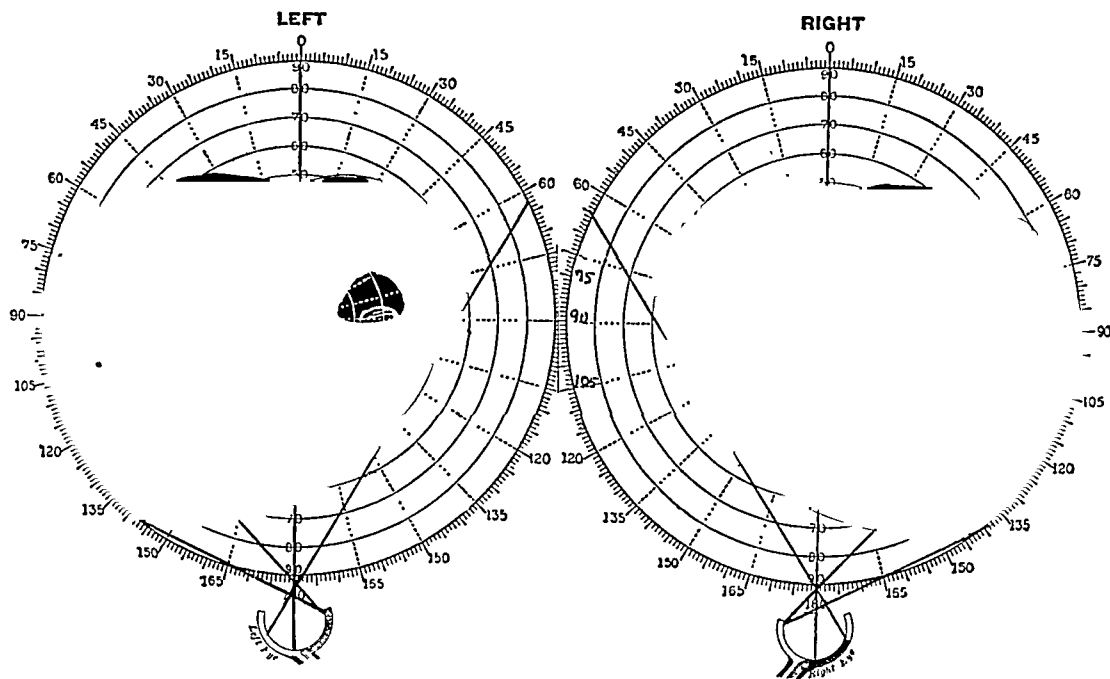


FIG. 35. Case ix. Fields: right eye blind, left eye central vision.



FIG. 36. Case ix. Advanced atrophy of dorsum sellae, erosion of sella floor with encroachment on sphenoid sinus.

growth was stunted, there was delayed development of the external sex characteristics, there was a primary optic atrophy and contraction of the visual field. Thus in

In contrast to this case, consider the following:

*Case VII. Summary.* Middle aged woman develops signs of pituitary dysfunction at first without change in fields or sella but later an homonymous hemianopsia. An exploratory (trans frontal) craniotomy but no tumor visible in prechiasmal or pituitary space. Some improvement followed by relapse with frontal lobe symptoms superimposed. A year after she first came under observation the patient succumbs (January 15, 1926). Pathological diagnosis: adamantinoma (retrochiasmal) of pharyngeal duct.

*CASE VII.* Mrs. C. W. K. aet. fifty years, File No. 4609 N.S. was referred to the Neurosurgical Service of the University Hospital by Dr. Burton Chance, Dec. 4, 1924.

*History.* The family history and history of previous illness were inconsequential. She was married and had had one miscarriage. April 1924, she noticed dimness of vision; it seemed as though a cloud were before the eyes. Since

May the sight has failed considerably. She has noticed no narrowing of her fields. She has a ravenous appetite, has gained from 173 to

was discharged December 11, 1924 to continue under Dr. Chance's observation.

*Readmission.* January 14, 1925. Since the

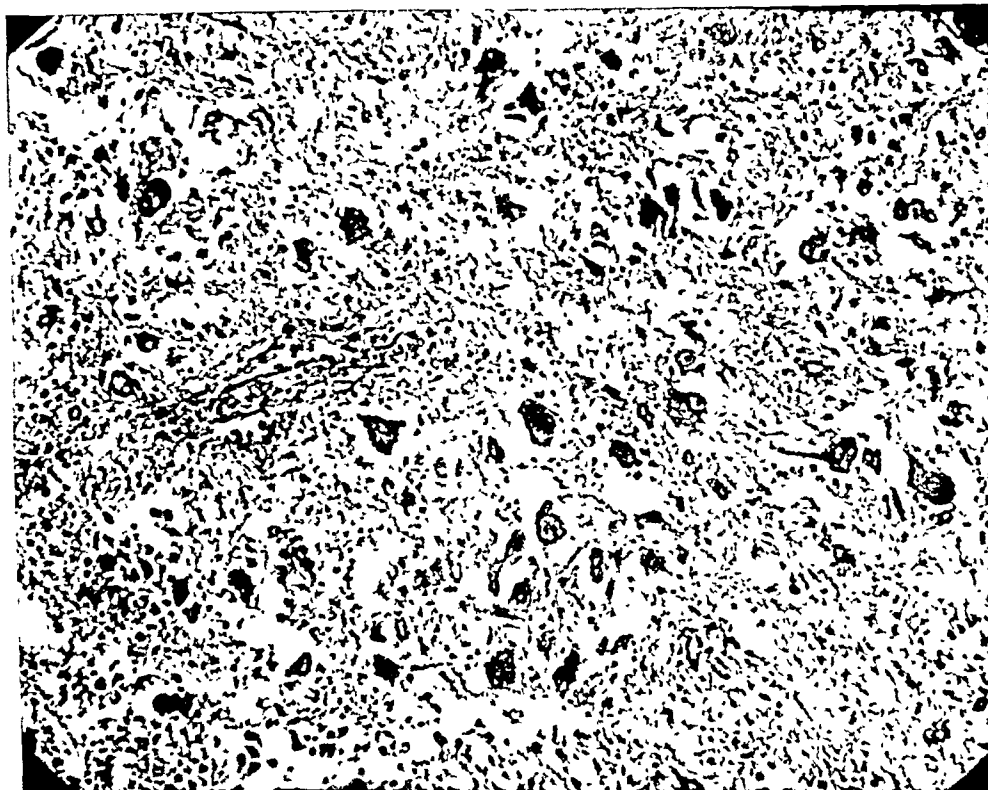


FIG. 37. Case ix. Low power photomicrograph of tumor showing numerous ganglion cells scattered throughout it.

243 pounds, is always tired and ready to sleep. She has to void frequently, sometimes every half hour. Since July she has been able to read only the headlines of the newspaper. In August she had an hallucination; thought she was surrounded by big black dogs. She is restless and has occasional bitemporal headaches.

*Examination.* On admission the following findings were noted.

*Endocrine Disturbances.* Accession in weight (70 pounds), fatigues easily, polyuria, basal metabolism minus 21. (Fig. 25.)

*Ocular Disturbances.* Vision O. D. 6/22, O. S. 6/15. Diplopia, lack of convergence, pupils sluggish, fundi greyish-yellow color.

*Roentgenogram.* Sella turcica, depth 7.5 mm. A.P. 10.5 mm. In all other respects negative. (Fig. 26.)

*Barany reactions* suggested a cerebral rather than a cerebellar lesion.

In the absence of any signs of sellar deformation or any pressure phenomena the patient

last admission, December 4, 1924 there has been definite deterioration of vision and there developed for the first time marked field



FIG. 38. Case xi. Photograph of patient.

distortion. The nervousness, polyuria, headache and diplopia have persisted.

Further examination revealed a basal metabolism of minus 25, intracranial pressure 234

mm. and a left homonymous hemianopsia. (Fig. 27.) Her vision now is O.D. 6/30 O. S. 6/22. The measurements of the sella turcica have not changed ( $7.5 \times 10.5$ ).

With these manifest signs of pituitary dysfunction the oncoming field distortion, the deteriorating vision, a cranial exploration seemed indicated. Provisional diagnosis "extrasellar tumor."

*Operation.* Transfrontal craniotomy, right. January 19, 1925. Local anesthesia. Tumor not found. Flap reflected. Dura especially adherent, particularly in the region above the orbit. There appeared to be no increase in intracranial pressure. There was an excessive amount of cerebrospinal fluid which, upon evacuation, facilitated elevation of the frontal lobe. A liberal exposure was obtained of the chiasm and the optic nerves, but there was not a sign of tumor in the sella or out. The wound was closed. In the middle of the operation the blood pressure rose suddenly from 125 to 175, soon dropping back again to the original level. It seemed as though an additional amount of pituitrin might have been liberated during the manipulations.

Except for one convulsion, the patient's convalescence was uneventful, but before her discharge it was thought wise because of the negative findings in the pituitary region, to do a subtemporal decompression. This was performed February 11, 1925 (F. C. G.) and the patient was discharged February 25, 1925.

Included in the period February 25, 1925 to the date of her death, January 15, 1926, the following notations were made:

*March 10, 1925.* The patient is very much depressed, seems to have hallucinations, speaks of imaginary sounds, "the kids" "turtles."

*June 8, 1925.* The left homonymous hemianopsia has disappeared and vision is about the same. O. D. 2/60, O.S. 6/60. The discs are of fairly good color though somewhat blurred on the edges. Retinal veins engorged.

*June 19, 1925.* Patient depressed, childish, dirty in personal habits, has delusions, has enormous appetite, drinks 4 quarts of milk daily. Much headache.

*January 10, 1926.* She was readmitted to the hospital in a semistuporous state and died five days later, January 15, 1926. For the first time the sella had increased in size. Measurements A. P. 10.5 mm. V. 10 mm. (Formerly A.P. 10.5 mm. V. 7.5 mm.)

At this time the fields could not be taken; the patient was practically blind, but there was no elevation of the discs.

*Pathological Diagnosis.* Adamantinoma. (Figs. 28 and 29.)

Manifestly in this case we were not dealing with an intrasellar adenoma. Before the operation and when first seen we had in mind a suprasellar meningioma, as the patient was in her fiftieth year, and the tumors of embryonic origin usually, though not always, occur in adolescents.

Calcification is said to be characteristic of the craniopharyngioma, but there was no calcification in either of the 2 cases just cited and others might be cited from our series without calcareous deposits. Furthermore, it must be remembered, that in suprasellar meningiomata as well as in intrasellar adenomata calcification is sometimes observed. So that given a tumor without calcification and without any alterations in structure of the sella turcica, the dorsum sellae or clinoid processes, it seemed impossible before operation to make an exact diagnosis.

In this case it so happened that the field distortion was an homonymous hemianopsia. This was really of no diagnostic importance as we have observed that the fields in the craniopharyngeal adamantinomata are extremely variable; they include a bitemporal hemianopsia, homonymous and binasal hemianopsia, concentric contraction or no obscuration of the fields at all. It is interesting to note that in every case of bitemporal hemianopsia the tumor presented prechiasmal. In the binasal or homonymous hemianopsias the tumor was retrochiasmal.

The 2 cases of adamantinomata we have cited for illustration differed in this important respect, the first took its origin from the lower of the two epithelial rests and was largely prechiasmal and the latter from the upper of the two rests and was entirely retrochiasmal. A tumor of this origin may be, as it was in Case VII, wholly inaccessible. Not a vestige of the tumor was seen at the operation.

## VI. TERATOMA

Among the more unusual tumors that may take their origin from the region of the pituitary are the teratomata. In our entire series we have but 2 verified cases, one of which will be cited. Frankl Hochwurt<sup>1</sup> found only two examples in 97 pituitary tumors. Hosoi<sup>2</sup> collected 41 cases of teratomata of the brain, 17 of which were true teratomata and 23 teratoid tumors. Chiefly among the latter were 7 of pituitary origin and 2 of the pituitary region. The principal interest in these tumors has to do with their precise origin and composition. The ectodermal and mesodermal elements prevail. The endodermal tissue if present is of an embryonic type resembling the chorda, there are cystically dilated spaces lined with goblet cells and respiratory epithelium in close relation to cartilage. As one might expect these tumors arise near the midline where there is greater likelihood of misplacement of embryonal tissue.

*Case VIII. Summary.* A boy of nine years had signs of intracranial pressure for seven years. When first seen there was evidence only of a right sided temporo-parietal tumor. In the course of the next six years evidence of a suprasellar lesion gradually developed. The tumor proved to be a teratoma.

CASE VIII. E. K. male aet. nine years, File No. 65844 was admitted to the Neurosurgical Service of the University Hospital June 1, 1922.

*History.* From his second year he was subject to severe headaches and spells of vomiting at two week intervals. At that time he was above the average intelligence, but took little part in games. Six months ago it was noticed his mouth was drawn to the right. His gait became unsteady and his memory began to fail. His head was increasing rapidly in size and a month ago there was a bulging on the right side of the head. Then followed general convulsions, two or three a day.

*Examination.* Somewhat underdeveloped physically and now of inferior mental grade.

<sup>1</sup> *Wien. med. Wchnschr.*, 59: 2326, 1909.

<sup>2</sup> *Arch. Path.* 9: 1207, 1930.

The left arm and leg are manifestly weak and there is a partial paralysis of the face of central origin. The tendon reflexes are exaggerated on the left side with a positive Babinski on the left. There seems to be impairment of pain sense on the left side of the body and face; also left sided adiadokokinesis and dysmetria. There is a lobulated swelling in the right temporal region. The surface is hard except at one point, the size of the tip of one's finger, which can be depressed upon pressure.

*Ocular Disturbances.* Discs O. D. plus 5, O. S. plus 4. Horizontal nystagmus on lateral rotation and slight rotatory nystagmus on upward rotations. (Fig. 30.)

*Roentgenogram.* Convolutional atrophy. Increase in size of sella.

*Cerebrospinal Fluid.* Pressure 260 mm. Globulin negative. Cells 5.

*Operation.* Exploratory craniotomy. Upon introduction of a canula, when the flap was reflected, 170 c.c. of a yellowish oily fluid were evacuated. A portion of the cortex over the cyst was removed for examination and the wound closed. (Fig. 31.)

*Postoperative Note.* Before discharge the hemiparesis had disappeared and he had no more convulsions. From that time until his death, December 17, 1927 he had been readmitted to the hospital five times. On three occasions the cyst was evacuated. A fourth attempt failed. The cyst cavity had evidently become filled with the tumor mass. On the last admission an exploratory craniotomy, transfrontal, was performed. The tumor was exposed but not removed. At the autopsy a large calcified tumor was revealed which proved on examination to be a teratoma. (Fig. 32.)

During the six years he was under observation the clinical picture changed in many respects. He developed (1), sexual characteristics suggesting pineal invasion (Fig. 33), (2) a left homonymous hemianopsia and (3) an x-ray evidence of suprasellar calcification. (Fig. 34.)

*Discussion.* In this case the prevailing evidence of a right hemispheric lesion was misleading. It was not until later that we discovered by x-ray evidence that the cyst floor was in juxtaposition to the sella turcica. When still later an homonymous hemianopsia developed and the x-ray revealed calcification our minds turned to a



tumor of embryonic origin, whether a duct tumor or a teratoma was problematical.

Because of the age of the patient, the first symptom was observed in his second year, one might presume a tumor of congenital origin, although neither teratomata nor duct tumors develop solely in childhood. There may be changes in the sella, but these are not such as are found in the primary intrasellar adenoma.

#### VII. GANGLIONEUROMA

Of the 70 cases of ganglioneuroma reported in literature 18 occurred in the central nervous system, 4 were from the tuber cinereum. It is not at all unlikely that these tumors arise from inactive cells of the original basal plates, which do not have a definite function. According to Courville<sup>1</sup> through some form of stimulation these cells assume a neoplastic nature and progress through the stages which lead to the adult form of cell.

*Case ix. Summary.* An adolescent for four years has signs of intracranial pressure, which later become acute. Apart from pressure phenomena, a block of the third ventricle, atrophy of the dorsum sella and enlargement of the sella turcica, there are no localizing phenomena.

*CASE IX.* E. G. male, aet. sixteen years, File No. 17449, was admitted to the Neurosurgical Service of the University Hospital 11.18.29, complaining chiefly of headache and pain behind the ears.

*History.* The patient has had headache and pain behind the ears for four years. These attacks occurred at intervals of a few days usually morning and night and at times were associated with nausea and vomiting. One year ago he began to have difficulty in reading; the print seemed blurred and glasses failed to improve vision. There was little variation in his condition until four weeks ago when the headaches increased in frequency and severity and were almost constant. He cannot read now and for the past two weeks has had transitory blind spells lasting a minute or two.

*Examination.* A well-nourished boy, his gait somewhat unsteady with tendency to

fall to the right. Intelligent and cooperative, expression apathetic.

With the left hand he past points in the vertical plane 3 inches to the right; in the horizontal plane with the left hand he drops 2 inches.

There are no involuntary movements, no paralyses and no objective disturbances.

*Ocular Disturbances.* O. S. and O. D. plus 5 D. Vision is lost in the right eye and only slight perception in the central field of the left eye. There is no reaction on either side to light consensual, direct, accommodation or convergence. There is weakness of the left external rectus. No nystagmus. (Fig. 35.)

*Roentgenogram.* Atrophy of the dorsum aellae, advanced, erosion of the sellar floor, which encroaches on the sphenoid sinus. The pituitary fossa is enlarged. (Fig. 36.)

*Cerebrospinal Fluid.* Pressure 640 mm. Cells 6, protein 3 units. Wassermann reaction negative.

*Operation* (F. C. G.) December 11, 1929. A ventriculogram showed enlarged lateral ventricles and obliteration of the third ventricle. A large right transfrontal flap was reflected and when the right ventricle was tapped the right hemisphere collapsed. Upon elevation of the frontal lobe as in the approach to a pituitary lesion, the tumor was exposed. The capsule was incised and the solid contents removed by suction. It did not seem feasible to remove the tumor. Pressure had been relieved upon the right optic nerve, but the chiasm was not seen. After decompressing in the temporal region the wound was closed.

Six hours after operation the left ventricle was tapped and the following morning the right ventricle. At this time hypothermia set in and the patient died in the course of the afternoon.

*Pathological Diagnosis.* Ganglioneuroma. (Fig. 37.)

*Discussion.* The striking features in this case were the duration of the illness, four years, the age of the patient, the absence of calcification, of endocrine symptoms of field distortion and obliteration of the third ventricle. As ganglioneuromata arise most commonly in the tuber cinereum, in the floor of the third ventricle, one would expect as an early symptom pressure phenomena, headache and papilledema.

<sup>1</sup> Arch. Neurol. & Psychiat., 24: 488, 1930.

This relationship accounts for the sudden deaths from pressure that have been reported in a number of cases. Differentiation from a true pituitary lesion in this case might be based upon the absence of endocrine symptoms and the characteristic sellar deformation; from tumors of the craniopharyngeal duct by the absence of calcification and hemianopsia. Hemianopsia is not uncommon in craniopharyngeal duct tumors but hemianopsia has not been recorded in the ganglioneuromata. Before operation it will always be difficult to make positive assertions. But evidence of a tumor in a youth or young adult, with evidence of third ventricle obstruction, with atrophy of the dorsum sellae, without calcification and without hemianopsia should lead one to think of a congenital tumor, possibly ganglioneuroma, in this neighborhood.

#### VIII. SUPRASELLAR ARACHNITIS— PSEUDOTUMOR

In a previous communication I have recorded 22 cases of pseudotumor.<sup>1</sup> Half of these were in the posterior fossa, the other half were pretentorial. The underlying pathology is alleged to be a localized arachnitis, but the pathological diagnosis has been confirmed but once. As a matter of fact, we know little if anything of the etiology or pathology. The most that one can say is that occasionally localized collections of fluid may give rise to symptoms which simulate tumors. Hence the term, pseudotumor, as Nonne first designated this condition.

*Case x. Summary.* With symptoms suggesting a lesion in the pituitary region, six years after the evacuation of cerebrospinal fluid at a transfrontal exploration, vision is conserved and the patient physically well and actively engaged in business.

CASE X. O. T. G. aet. twenty-one years, male. File No. 2759 N.S. was admitted to the Neurosurgical Service of the University Hospital January 14, 1924.

<sup>1</sup> *Arch. Neurol. & Psychiat.*, Dec. 1930.

*History.* The patient had had measles as a child. At the age of seven he noticed he could not see as well with the right eye. Between his seventh and his fourteenth year he had convulsions. At fourteen he developed diplopia. For the past three years he has had visual hallucinations (sees zig-zag lines like streaks of lightning).

*Examination.* The patient weighed 210 pounds, the fingers were tapering, there were deposits of fat suggesting pituitary dysfunction. His basal metabolism was minus 22. He had a right homonymous hemianopsia. In other respects his examination was negative.

*Operation.* Transfrontal craniotomy January 23, 1924. Apart from an excessive collection of fluid the exploration was negative.

*Postoperative Note.* Six years after the operation he wrote that he had not felt so well for years. He had gained only 3 pounds, his vision had not deteriorated (O. D. 6/15, O. S. 6/9). The hemianopsia had persisted.

*Discussion.* This case is cited merely to illustrate the possibility of mistaking a pseudotumor for a solid tumor in the pituitary region. There was no reason to suspect a true pituitary tumor in this instance as the sella was not enlarged. But there were suggestive pituitary stigmata and field distortions. We are so accustomed in our operations in the suprasellar region to find a considerable quantity of cerebrospinal fluid that we were not surprised to find an abundance of fluid in this particular case. It was not until six years had elapsed and there was no evidence of recurrence or progression that we classified this case as "pseudotumor."

In this discussion of the differential diagnosis of tumors intrasellar and parasellar, I have not referred to glioma of the chiasm or to aneurysms. The former is relatively infrequent, the diagnosis is usually conjectural unless there is a definite excavation under the anterior clinoid processes. The patients are mostly adolescents and there is of course a bitemporal restriction of the fields.

One is unlikely to confuse an aneurysm of the internal carotid artery or the circle of Willis with a sellar or suprasellar tumor.

Usually not suspected until the time of rupture, violent headache, bloody cerebrospinal fluid with loss of consciousness for the first time reveals the true nature of the lesion. Paralysis of the third, fourth and sixth cranial nerves may eventuate with anesthesia in the trigeminal distribution.

#### IX. SUPRASellar FIBROBLASTOMATA

Finally, there remain for consideration the suprasellar fibroblastomata or meningiomata which originate at the tubercle of the sella turcica.

Reviewing the cases which have passed through our clinic, the following seem to be outstanding features; the patients are adults, mostly between forty and fifty; the duration of the symptoms is expressed in years not months, headache is common; the roentgenogram may be normal or at most there is atrophy of the clinoid processes, never ballooning of the sella turcica; there is asymmetry of the visual picture, the vision of one eye almost always affected before the other; field distortions may or may not be present and if present they may be of various types, hemianopsias, central or temporal scotomata; primary optic atrophy, not papilledema, is invariable; if the tumor be large and involve adjacent structures there may be a hemiparesis loss of sense of smell, dreamy states.

The following case is more or less illustrative of the suprasellar fibroblastoma.

*Case XI. Summary.* A suprasellar fibroblastoma is removed from a middle-aged patient who began to complain of blurred vision six years ago. Apart from primary optic atrophy there were no suggestive symptoms. The x-ray was normal.

CASE XI. E. J. B. female, aet. fifty-one years, File No. 8215 N. S. was admitted to the Neurosurgical Service of the University Hospital April 28, 1926. (Fig. 38.)

*History.* For six years there had been blurring of vision in her right eye and three years ago there appeared a mist before the left eye. Two years ago she lost vision in the right eye. About this time she was drowsy most of the time and would fall asleep frequently. She had occasional headaches mostly bitemporal and a form of visual hallucinations, which she described as a picture of autumn leaves.

*Examination.* With the exception of her visual disturbance the examination was entirely negative, except for signs of primary optic atrophy. The roentgenogram was normal in that the sella was not enlarged. At most there might have been a slight atrophy of the posterior clinoid processes.

*Operation.* Through a left transfrontal exposure an encapsulated tumor the size of a plum was revealed. The right optic nerve was displaced to the outer side of the growth. A subcapsular removal of the tumor was effected and the wound was closed.

*Postoperative Note.* The patient made an uneventful convalescence and four years after the operation was in good health. Unfortunately the optic atrophy was so far advanced that vision was not restored.

*Discussion.* The duration of the lesion, the absence of sellar deformation and the age of the patient clearly differentiated this lesion from one of pituitary origin, if intrasellar. One might be confused were the lesion a suprasellar adenoma, but with the latter the development is more rapid, the average age younger, and there is more likely to be evidence of pituitary disturbance of one variety or another.

There is little in common between the suprasellar fibroblastoma and the craniopharyngeal tumor, except in that both there may be no striking alterations in the conformation of the sella turcica. In the stalk tumors the patients are usually younger, calcification more common, papilloedema not infrequent and if endocrine disturbances are present, as they often are, they are drowsiness, femininity, adiposity, infantilism and sex depression.

# A MODIFICATION OF THE DEVINE OPERATION OF PYLORIC EXCLUSION FOR DUODENAL ULCER\*

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WHEN a duodenal ulcer is complicated by gastric retention due to an organic stenosis it is the con-

ity of this procedure is made in this presentation.

While the operation of gastroenteros-

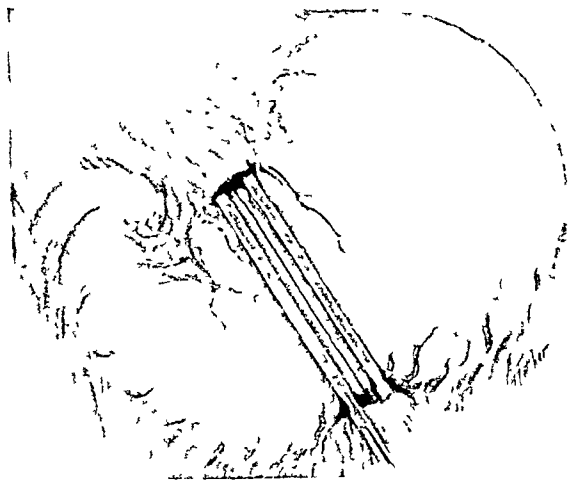


FIG. 1. Ligation of vessels in gastrohepatic and gastrosplenic omentums, insertion of proximal crushing clamp through transverse mesocolon and distal clamp inserted across stomach proximal to reentrant angle.

sensus of opinion that gastroenterostomy is the operation of choice, but where there is a postpyloric lesion without retention gastroenterostomy has not given as satisfactory results as one might wish. This is indicated by the numerous operative procedures that have been devised in place of gastroenterostomy, such as the Horsley, Judd and Finney pyloroplasty, and finally the subtotal gastrectomy. This last procedure, in the hands of the general surgeon, presents a mortality which precludes its adoption as the operation of choice. Feeling, therefore, that there is a middle path in the surgical treatment of duodenal ulcer that is more satisfactory than gastroenterostomy and less radical than subtotal gastrectomy, we present a modification of the Devine operation of antral trans-section and exclusion with a Polya gastrojejunostomy. No claim for original-



FIG. 2. Antrum of stomach after removal of distal clamp. Insertion of temporary rubber band tourniquet to diminish bleeding. Dotted lines: Schematic relationship of vessels. Insert shows method of controlling tourniquet.

tomy is relatively simple in textbook description it is, from a technical point of view, not so easy to perform.

After the mesocolon has been perforated and the posterior surface of the stomach drawn into the operative wound and the proximal loop isolated, it is difficult to feel sure that the line of the stoma or the direction of the jejunum is in position to allow satisfactory function after replacement of the viscera within the abdominal cavity. Moreover, even in the hands of good surgeons, the mortality is higher than it is generally believed to be.

Devine<sup>1</sup> described an operation wherein he cut across the antrum of the stomach

<sup>1</sup> Devine, H. B. Gastric exclusion. *Surg. Gynec. Obst.*, 47: 239, 1928.

\* Read before the Southern Surgical Association, December 8, 1931.

at about the reentrant angle, inverted the distal portion and drew the proximal portion through the mesocolon and per-

mentally the antral pouch, while contracted, contains a greenish detritus which would seem to be obnoxious.

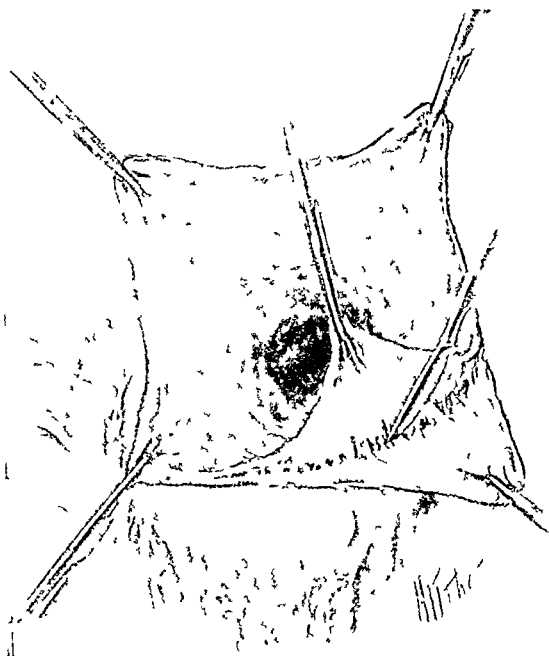


FIG 3 Beginning dissection of mucosa from muscularis of antrum.



FIG. 4. Completion of dissection of mucosa. Clamps applied before insertion of inverting mucosal suture.

formed a Polya anastomosis with the proximal loop of jejunum. Theoretically this operation has the following advantages over subtotal gastrectomy: (1) It is unnecessary to dissect the antrum and pylorus free from the gastrohepatic and gastrocolic omenta. (2) It obviates the necessity of dissecting ulcers located on the posterior surfaces of the duodenum from the head of the pancreas. (3) Where the ulcer is situated near the papilla of Vater closure of the duodenum stump has presented marked technical difficulties; these difficulties are obviated by this operation. It has the following theoretical disadvantages: (1) There is left a gastric mucous membrane in the distal portion of the stomach which may continue to bathe the ulcer with its secretion and thereby delay healing. (2) It is generally considered an inadvisable surgical procedure to leave a blind pouch anywhere in the gastrointestinal course. In dogs where this operation has been done experi-

As a means of correcting the aforementioned disadvantages of the Devine operation, Dr. Lewis Gregory Cole suggested that this operation could be improved by coning out the mucous membrane of the antrum as far as the pylorus and then inverting the mucosa and muscular coats. The details of this procedure are to be described in the latter part of this article. At the beginning of my connection with the Fifth Avenue Hospital, Dr. Cole, chief of the radiological department, Dr. Tenney, chief of the medical department, and myself, as chief of the surgical department, came to a working agreement that no case of duodenal ulcer should be referred for operation unless two out of the three decided that operation was advisable. It was our opinion that no case should become surgical unless it had had a prolonged and satisfactory course of medical treatment or unless there was radiological evidence that perforation might ensue unless operative pro-

cedure was carried out. As a result of this agreement the surgical department has not had a great number of cases referred for operation: In addition, the cases that have been referred are obviously medical failures and therefore should not be grouped on equal terms in analyzing follow-up results with early submucous ulcers, duodenitis and similar conditions which are included in any analysis of medical treatment of ulcer.

I propose to present 14 consecutive cases of duodenal ulcer subjected to the modified Devine operation of pyloric exclusion. I realize that this series is small and that a follow-up of three and one-half years, which have elapsed in the oldest cases, is not sufficient for a complete end-result analysis; but this is a carefully selected series of cases that have defied medical treatment and wherein it has been the consensus of opinion of the attending physician, surgeon and radiologist that operative procedure is indicated.

In an earlier discussion with Dr. Cole about the end results of the patients subjected to operation he made the statement that no surgeon could give a proper evaluation of his own operation any more than a father could properly evaluate his own son. I then made the suggestion that I would send for all cases operated upon and leave the evaluation of the follow-up to Dr. Cole and would stand by his conclusions. As Dr. Cole has been opposed in general to operative procedure in duodenal ulcers it would seem that the study of end results is fairly accurate.

#### DESCRIPTION OF OPERATION

As the illustrations show clearly the steps of the operative procedure only the important points will be mentioned. We have found that the incision described by Tate Mason gives the best exposure of the stomach and appendix. After opening the peritoneum and inspecting the pathology of the stomach and duodenum the vessels of the lesser curvature are ligated just proximal to the reentrant angle over

an area sufficient to insert two gastric clamps. A similar procedure is carried out on the greater curvature opposite

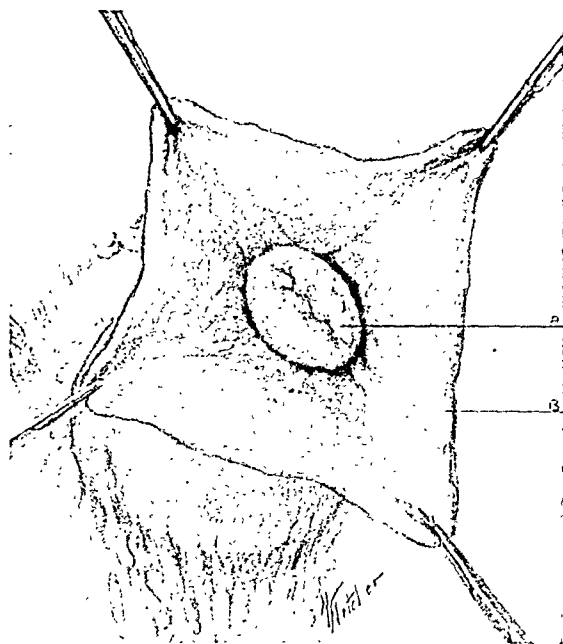


FIG. 5. Completion of inverting mucosal stitch. Antrum is then closed with two to three purse-string sutures, final one being an inverting peritoneal suture.

the site chosen on the lesser curvature. Next the transverse colon is drawn up into the wound and its mesocolon is perforated in the avascular area. A Peyer crushing clamp is inserted through this perforation so that the blades pass one on each surface of the stomach. A second non-crushing clamp is applied distal to the Peyer clamp but is inserted through the perforation of the gastocolic omentum and not through mesocolon. (See Fig. 1.)

The stomach is cut across close to the crushing clamp with either cautery or carbolyzed knife. The Peyer clamp enclosing the proximal portion of the stomach is wrapped in a sterile string pad, to protect the wound from contamination. Allis clamps are applied to the cut end of the distal portion, the distal gastric clamp is removed and the lumen of the antrum exposed. (Fig. 2.) At this stage a finger may be passed through the pylorus and the lumen of the duodenum palpated

from within for ulcer. I have found that if a rubber band is applied as a temporary tourniquet about the pylorus, as shown in

purse-string sutures and a final inverting peritoneal suture.

Figures 6 and 7 show the latter steps of

FIG. 6.

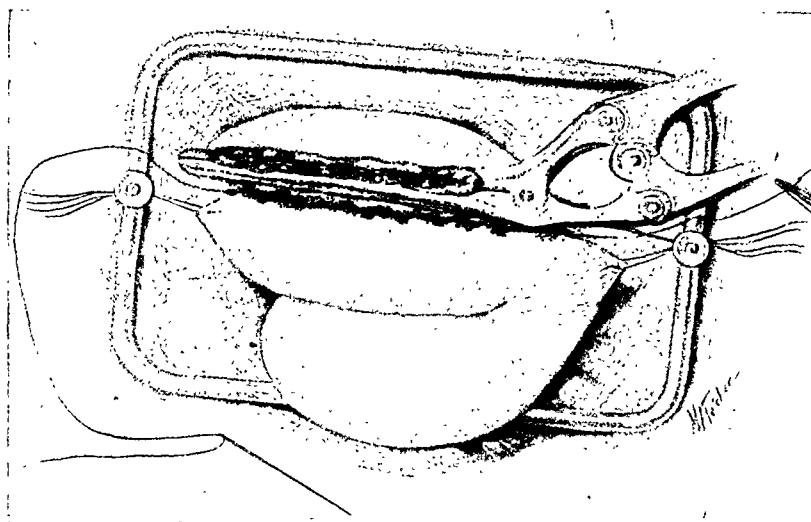


FIG. 7.

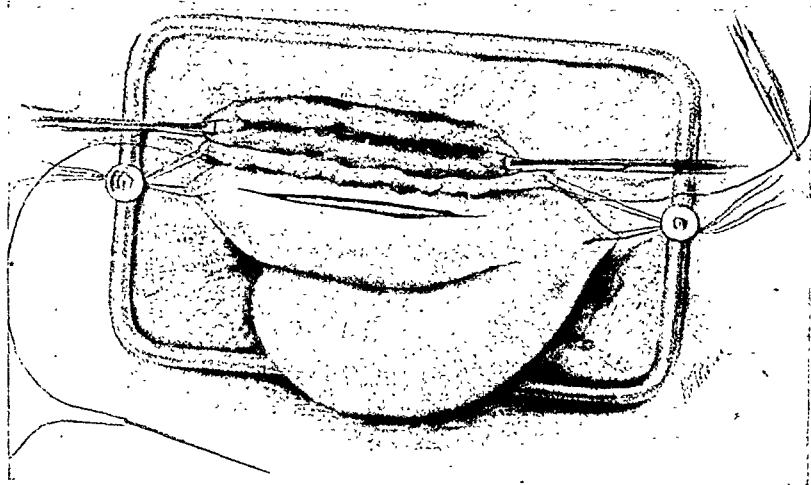


FIG. 6. Proximal portion of stomach drawn through transverse mesocolon and beginning anastomosis with proximal portion of jejunum. Lesser curvature is united to proximal portion of jejunum shortly after its emergence from fossa of Treitz.

FIG. 7. Continuation of anastomosis after portion of stomach which has been held by bite of crushing clamp has been excised.

Figure 3, it diminishes the bleeding while the mucosa is being excised.

The dissection of the mucosal layer is carried out as shown in Figures 4 and 5. When the prepyloric area is approached a Kocher clamp is applied and the dissected mucosa excised. The pyloric mucosa is closed with an inverting suture. The temporary tourniquet is then removed, bleeding points are clamped and ligated, and the antrum closed with two or three

the anastomosis. The jejunum is isolated close to where it presents from the fossa of Treitz and is anastomosed side to end with the stomach so that the proximal portion of the jejunum, about 4 to 7 cm. from the fossa of Treitz, is attached to the lesser curvature. The anastomosis is made *without* clamps after the excision of the portion of the stomach within the bite of the Peyer crushing clamp. Care is taken to ligate all bleeding points. Three layers of sutures

are applied anteriorly and posteriorly, particular care being used to unite the mucous membrane. Figures 8 and 9 show

Postoperatively fluids are administered either subcutaneously or intravenously the day of operation and the first two days

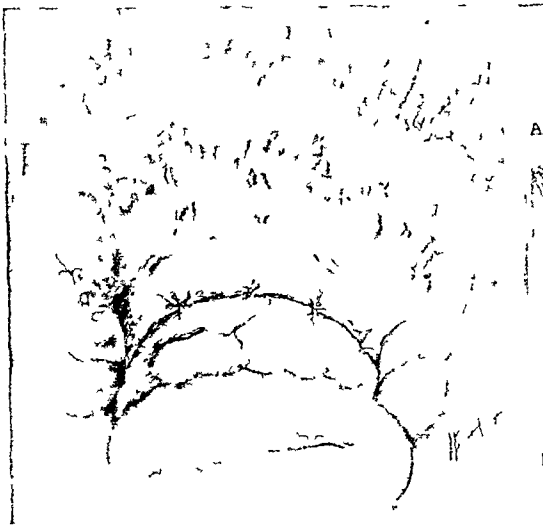


FIG. 8 Appearance of anastomosis after its completion, showing mesocolon united to stomach 1 to 2 cm proximal to anastomosis.



FIG. 9 Appearance of stomach and inverted antrum at completion of operation. A, Ulcer. B, Inverted antrum. C, Schematic sketch of retrocolic gastrojejunostomy.

the operative procedure complete. Follow-up roentgenographs show that with the anastomosis made as described above there is a free exit of the barium meal from the distal loop and no pocketing in the proximal loop. (Fig. 10.)

Success or failure of any operative procedure is largely dependent upon the ante-operative and postoperative therapy; therefore, the routine procedures are shown in Tables I and II. In the ante-operative therapy particular stress is laid upon the subcutaneous administration of fluid; in addition a gastric lavage the morning of operation is given in order to have a clean surface for anastomosis.

As the operation is frequently associated with an appendectomy and may take an hour and a half, the choice of anesthesia is important. Nearly all the cases have been done under ethylene and recently under avertin and ethylene. We have no objection to spinal anesthesia but feel that our results with ethylene have justified its continuance as the anesthesia of choice.

postoperative. It is our contention that fluids should be administered before there is definite indication, because once that time arrives it is often too late.

The use of the Levin tube inserted through the nares immediately after the

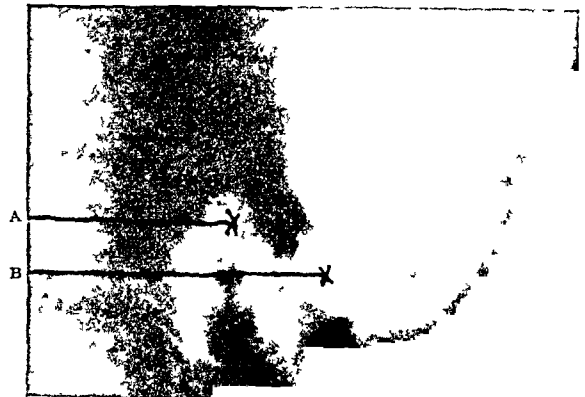


FIG. 10. Postoperative gastric radiograph. A, Beginning jejunum at fossa of Treitz. B, Stoma

patient has regained consciousness is a life-saving measure. The nurse is instructed to use a 50 c.c. syringe and to irrigate and suck out the stomach every two hours



TABLE I  
CASE ANALYSIS

Case Number	51817	51237	51191	50789	49829	45435	44134	41545	39919	36533	36106	33841	31269	53467
Duration of symptoms.....	8 yrs.	8 yrs.	4 yrs.	4 yrs.	4 mo.	7 yrs.	7 mo.	5 yrs.	1 yr.	2 yrs.	3 yrs.	5 yrs.	7 yrs.	1 yr.
Duration of medical treatment.	5 mo.	Sporadic	None	1½ yrs.	4 mo.	3 yrs.	None	5 yrs.	None	2 yrs. sporadic	None had op. for perfr.	5 yrs. sporadic	None	1 mo.
Dental treatment...	Proph.	Teeth O.K.	Teeth O.K.	Teeth O.K.	Proph.	Extraction and proph.	Proph.	Teeth O.K.	Teeth O.K.	Teeth O.K.	Proph.	None	None	Teeth O.K.
Length of pre-op. treatment.....	½ day	1½ day	2 days	5 days	2 days	4 days	3 days	2 days	3 days	3 days	5 days	9 days	5 days	4 days
Pre-op. diet.....	None	Smithie 3 wk.	Bland	Smithie 7-14	Smithie 3-7	Gruel	High calorie	Soft	.....	Smithie	Regular	Sippy	Smithie	Sippy
Anesthetic.....	Ethylene	N <sub>2</sub> O and ether	Ethylene	Ethylene	Avertin and ethylene	Ethylene	Ethylene	Ethylene	Ethylene and ether	Ethylene and ether	Ethylene	Ethylene	Ethylene	Avertin and ethylene
Associated operation	None	Chol'ectomy	Append.	None	Append.	Append.	Append.	Append. and chol'ectomy	Append	None	None	None	None	Append. and chol'ectomy
Hypodermoclysis....	4	2	5	2	4	3	1	3-2	3	1	2	4	3	4
Wound infection....	Hematoma	0	0	0	Appendix wound	0	0	0	0	0	Yes	0	0	Biliary fistula 8th day P.O.
Complications.....	0	0	0	0	0	0	Pneumonia	Int. obs. jejunostomy	0	0	0	0	Bronchitis	Lobar pneumonia
Out of bed.....	16	12	11	12	14	12	13	20	12	14	20	15	16	
Discharged.....	20	14	13	15	17	15	16	23	15	19	22	18	19	In hospital
Immediate result...	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good	
Late result.....	Good 4 mo.	Good 6 mo.	Good 6 mo.	Good 6 mo.	Good 7 mo.	Good 1 yr.	Good 1 yr.	Died 2 yr. intestinal obstruction	Fair 2 yrs. 50% relieved	Fair 2 yrs. good if on diet	Good	Good 3 yrs.	Good 3 yrs.	

day and night for the first forty-eight hours postoperative. The suction removes blood clot and gas and prevents postoperative vomiting and dilatation. When the washings return relatively clear in two successive irrigations the tube is removed, and if the operator is not certain

a jejunostomy was performed, the patient was fed through this and made a relatively slow recovery. A further description of her case will be given under late results. There were two wound infections.

*Late Complications.* Two of the series, who had wound infections, showed inci-

TABLE II  
POSTOPERATIVE ROUTINE

	Preop.	Day of op.	1st day postop.	2nd day postop.	3rd day postop.
Fluids by mouth	Forced	None	Aq. 1 oz. q. ½ h.	Aq. 1 oz. pep. mk. 1 oz. alternating q. 2 h.	Aq. 2 oz. pep. mk. 2 oz. alternating q. 2 h.
Fluids by rectum .	None	5 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.	3 oz. q. 3 h.
Hypodermoclysis	Once	Once	Twice	As indicated	None
Lavage .	Twice	q. 2 h.	q. 2 h.	As indicated	None
Enemas and colon irrigations	Enema twice	None	Colonic	Colonic	Colonic

of the condition of the stomach it is reinserted six hours later and suction and irrigation applied to be sure there is no dilatation. Table II gives the details of the postoperative therapy in this series.

#### REVIEW OF CASES

*Immediate Postoperative Complications.* There was no death in this series. There was one postoperative pneumonitis with an elevation of temperature for four days, with x-ray confirmation; one bronchitis, with suppurative sputum and elevation of temperature for three days, x-ray evidence showing peribronchial infiltration.

In the last patient operated upon under this procedure the operation was complicated by an appendectomy and cholecystectomy for numerous gallstones. On the eighth day the patient developed a biliary fistula complicated with a right lower lobe pneumonia. The biliary fistula as a complication does not seem attributable to the gastric operation. One patient had persistent vomiting for five days with apparently an obstruction of the distal loop of the stoma. Under local anesthesia

sional hernia on return to the follow-up clinic at the end of a year.

One patient died a year and a half postoperatively, of intestinal obstruction. This is the patient upon whom a jejunostomy was done following the operative procedure. She continued to have gastric and intestinal symptoms following the original operation and was treated by a very competent gastroenterologist in Chicago. A year and a half later, while I was out of the city, she returned with signs of intestinal obstruction and was operated upon by one of my associates. She had symptoms of persistent vomiting and pain in the epigastrium. At operation he found that the small intestines were dilated and congested. A jejunostomy was performed. She recovered slowly and was able to leave the hospital, although not completely well, and returned a month later with a second attack of vomiting and obstruction. At this time I operated upon her and performed a short circuiting operation between a distended and contracted loop. She developed further obstructive symptoms and peritonitis, and died. At postmortem examination in addition to a diffuse peritonitis it was found that there

was a herniation of a loop of jejunum just distal to the anastomosis through the mesocolon posterior to the stomach into the lesser sac. In reviewing this case with our follow-up, x-rays and history of her symptomatology, it seems evident that she developed this herniation shortly after her first operation and it had persisted in this position until her exodus.

At the time of the original operation the mesocolon was sutured to the anterior surface of the stomach but not to the posterior. It has been to the writer an object lesson of the necessity of suturing the mesocolon to the posterior as well as the anterior gastric surface in performing an anastomosis.

*Follow-up.* As shown in Table 1, 10 cases are reported as excellent, 2 as fair and one as poor, the patient having died of intestinal obstruction. One has been operated upon too recently to warrant any conclusions. Twelve of the 14 would recommend operation to any friend of

theirs. Eight eat everything; 4 are well if they omit certain articles of food, such as fried foods and food with much residue. If they depart from their diet they have some gas and distress after eating, but nothing compared to the symptoms they suffered before operation.

#### CONCLUSIONS

The modification of the Devine operation in a small series of cases has proved to have a low enough mortality and satisfactory enough end results to warrant its use in postpyloric ulcers where the ulcers are adherent to the pancreas or in the neighborhood of the papilla of Vater. Its use is advocated in patients who have defied medical care and in those where there is no marked gastric retention.

I wish to express my thanks to Dr. Charles W. Lester for having tabulated the results and to Dr. Lewis Gregory Cole for much valuable advice.



# TUMORS OF THE CECUM\*

## A DISCUSSION AND REPORT OF SEVENTY CASES

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IN a previous communication on this subject I reported with Harold E. Clark, my assistant, 48 cases operated upon by me in a few years preceding January, 1927, and from that date up to October, 1931, a period of four years, I am adding 22 cases, making a total of 70.

Among the more common tumors of the cecum appearing in the literature of the day are the cystic, including dermoid, epidermoid and entero-cystoma, and the limomyoma, actinomycosis, and lymphosarcoma, while standing out most prominently are carcinoma, tuberculosis, chronic inflammatory hypertrophy and the occasional lymphosarcoma. These growths from carcinoma to lymphosarcoma are mentioned in the order of frequency as seen by me.

Carcinoma was found in 56 cases, tuberculosis in 9, chronic inflammatory in 2, lymphosarcoma in one, polyposis in one and undetermined pathology in one.

While the pathology of the "undetermined pathology" cases and several of the tuberculous was in doubt, evidences of tuberculosis or manifestations allied to tuberculosis caused me to add them to the tuberculous.

Twice I have had actinomycotic associations with the cecum. One was in a case of appendicitis with mass formation. The patient was operated upon and a gangrenous appendix and a large abscess were found. Persistent sinuses followed with a final finding of actinomycosis organisms. Liberal doses of potassium iodide were instituted. So far, for a period of eight years, no further evidence has manifested itself.

Another case, seen lately, has been diagnosed in the West as actinomycosis. There was a history of appendicitis and operation followed by a large pelvic mass almost filling the pelvis. On examination by me there were two large granulating areas in the lower right quadrant and the buttock of that side. The patient was in a most pitiable state.

These two cases are not included in the list of tumors as I did not consider the first as a primary actinomycotic growth and the second was not an operative patient of mine.

For the sake of completeness, a brief review of anatomy with emphasis on the cecal lymphatics is necessary.

### ANATOMY

In a normal adult the cecum is about 2½ inches in length. A fold running from the top of the ileum partly around the large gut marks the boundary between the cecum and the colon. The cecum differs from the rest of the large gut in that it is more richly supplied by the lymphatics. It is lined with a single layer of columnar cells. Villi and valvulae conniventes are absent.

The vessels of the mesentery and nerves enter the cecum and colon from the inner or left side. This may be explained embryologically since the cecum and the colon originally occupy the left lower abdominal segment; later they rotate to the right, remaining permanently in the right iliac fossa.

The blood supply to the cecum is the ileocolic branch of the superior mesenteric. The ascending colon is supplied by the

\* Read before The Academy of Surgery of Detroit, Michigan, Dec. 10, 1931.

right colic and the transverse colon by the medial colic artery.

The lymphatic drainage follows the course of the ileocolic blood vessels. Frequently they are continuous with glands around the superior mesenteric artery. The terminations are associated with the ileocolic arterioles.

Lymph channels surround the glands of Lieberkühn where carcinoma of the cecum originates. From there they are directly continued to the network of the lymphatics in the submucosa. These pass through the muscle layers and form plexuses of lymphatics between the mesenteric sheaths.

The lymph systems may drain into five different groups of glands about the cecum or directly into the glands around the ileocolic artery above.

The groups as given by Craig and McCarty are: (1) Anterior colic. (2) Posterior colic. (3) Appendicular. (4) Ileal. (5) Right colic.

#### LYMPHOSARCOMA

Lymphosarcoma is an extremely rare disease of the cecum. During a period of fifteen years in Prague of 13,036 sections 13 cases were found. It does, however, occur with more frequency in the small intestines and the rectum.

The symptoms are similar to other types of cecal tumor occurring in early adult life. The tumor is extremely rapid-growing and non-tender. It begins in the submucosa made up of small or large round cells. Within a very short time the entire gut wall is infiltrated. The central portion breaks down and ulcerates. Extension takes place peripherally. With sarcomatous invasion the gut has a tendency to be dilated rather than to be constricted in contra-distinction to carcinoma. Polypoid excrescences are not usual.

The course is rapidly fatal. Metastases occur early in the contiguous lymphatics and likewise in the distant organs.

Early recognition and excision followed by roentgen and radium therapy offer the

best prognosis. A few cures have been reported.

In our series we had one case reported to be lymphosarcoma.

#### TUBERCULOSIS

There is now a rather general agreement that tuberculosis does occur primarily as well as secondarily in the cecal region. The pathological differences are quite marked. This in a given case together with absence of tuberculous foci in other regions furnishes strong support for those contending primary invasion.

Tuberculosis of the cecum is very common in patients having pulmonary involvement. At necropsy it has been demonstrated that the gastrointestinal tract is involved in 70 to 90 per cent of these cases (Hartman quoted by Menzies). Of this number the ileocecal region is involved in about 85 per cent of the instances. Only a relatively small number of this group receive surgical interference, and then only when symptoms of obstruction, fistulae and severe subjective signs are present.

The best explanation offered for the predilection of the ileocecal region is based on anatomy. As cited previously, the cecal region of the large gut, excepting the rectum, is the most abundantly supplied with lymphoid tissue. In children the infection is attributed to milk inoculation by the bovine type of bacillus. In adults it is ingested with the food, or transmitted through the blood stream, the organism being the human type.

The age incidence is early adult life between the second and third decades, although of our series of 7 cases reported, the average age was under twenty years. As regards sex, the distribution was equal.

There is nothing in the symptomatology characteristic of tuberculosis unless it be the insidious onset, chronicity and interval period of freedom from symptoms. The duration in our series extended from two months to five years.

Pain is an early evidence; distress at first, later cramp-like and irregular. Associated with this is tenderness and rigidity in the right lower quadrant. Obstinate constipation with diarrhea and blood-streaked mucous shreds is a prominent symptom. Epigastric discomfort, nausea, vomiting and belching occur early. The absence of temperature means little. Its presence, particularly in the afternoon, may augment the differential diagnosis.

Serum tests in adults are of very little aid. Pulmonary, osseous and glandular involvement must always be sought for. We were able to demonstrate phthisis in one instance, no extracecal focus in the others.

Brown, Levy and Haft all emphasize the difficulty of clinical recognition and stress the value of the roentgen examination.<sup>1</sup> Brown reports that in 28 cases diagnosed and operated, 27 were correctly diagnosed. His work upon this subject has been painstaking and most illuminative. The roentgen picture in cecal tuberculosis reveals hypermotility, spasticity and filling defect. Obstruction, when present, is likewise disclosed.

Pathologically there are two distinct types of cecal tuberculosis, ulcerative and hyperplastic.

*Ulcerative Tuberculosis.* Menzies describes this type as the enteroperitoneal group. The tubercles are first found in the mucous membrane. As they grow they coalesce, undergo central degeneration and produce superficial flat ulcers with undermined edges. Read states that the ulcers circle the gut because the lymphatics and vessels run circularly. As a result, when healing occurs, the cicatrix forms an obstructing band. He maintains that 25 per cent of the ulcerous type produce stricture or stenosis. Similar tubercles in the serosa produce a dense adhesive peritonitis. This group is considered a secondary manifestation of a primary focus elsewhere. It is surgical only when obstruction makes intervention imperative.

*Hyperplastic.* This group is considered to be primary in origin. Surgical excision frequently perfects a cure. The tubercles appear in the submucosa, growing there, causing thickening of the wall and narrowing of the lumen. Menzies claims that by the fibrolipomatous changes in the pericecal fat there is a tendency to self-limitation of the tumor.

Our cases represent both these types of tumor. It was observed that secondary infection had played an important part in the syndromes. All cases showed degrees of obstruction. Five were of the hyperplastic type, one of which was complicated by a fecal fistula. Two showed papillary projections of the mucous membrane. One was of the ulcerous, constricting type with the primary focus in the right middle lobe of the lung. It is interesting to note that all had, at various times, been diagnosed as appendicitis. Two had had appendectomies, one of which resulted in the fecal fistula mentioned above, the fistula being the result of a primary perforation of a tuberculous ulcer of the cecum.

A Friedreich resection with a side-to-side anastomosis of the ileum to the transverse colon was done in one stage in three instances. Because of the extreme dilatation of the ileum in the ulcerative case only the resection of the tumor and an ileostomy (Paul's tube) was attempted at the first stage. Eleven days later the anastomosis was completed similar to the others.

The results were uniformly good. There was one death out of 7 patients, a child two and one-half to three years old, with tuberculosis of the cecum who had an appendectomy done; the other patients left the hospital apparently cured. Responses to follow-up letters revealed freedom from symptoms and marked general improvement.

#### CARCINOMA

In this series of cases the youngest was twenty-one and the oldest seventy-eight.

<sup>1</sup> Also, see the article by J. W. Larimore and A. O. Fisher, *Ann. Surg.*, 83: 496, April, 1926.

Attention has been called to the fact that carcinoma of the intestinal tract occurs with far greater frequency in the foregut and the hindgut. The midgut, extending from the second portion of the duodenum to the ileocecal valve, is relatively free from invasions. It seems, therefore, that that portion of the gut functioning to prepare and digest food and also that portion which has to do with the storage and evacuation of unassimilated food is peculiarly susceptible to carcinomatous invasion.

Brill (quoted by Ewing), in reporting 3563 cases of malignancy of the intestines, found only 89, or 2.5 per cent of instances in which the small intestines were involved. Of this number the greatest percentage occurred in the second portion of the duodenum about the biliary pailla.

In an article by myself and R. F. Carter,<sup>1</sup> the senior author reports the following frequency of malignancies of the colon in a series of 129 cases: 50 in the recto-sigmoid, rectum and anus, 37 in the sigmoid, 18 in the cecum, 15 in the ascending colon, hepatic flexure and right half of the transverse colon and 9 in the left half of the transverse colon and splenic and descending colon.

Tissue predisposition is evident in those instances in which malignant changes develop from polyps of the colon. Trauma due to physiological and anatomical relationships plays a definite role. No doubt these portions of the-gut which are fixed and offer more resistance to fecal movements are subjected to a more constant irritation. This resistance probably is greatest at the ileocecal junction and at the rectal valves.

*Pathology.* Tumors of the cecum are characteristic of tumors elsewhere in the colon. They are slow growing, only moderately malignant, extending late and metastasizing less frequently than tumors of a similar nature in other organs.

Carcinoma begins in a circumscribed area of mucosa, with enlargement of the

glands and permeation of the basement membrane. This area gradually extends by progressive transformation of normal into neoplastic alveoli. Microscopically this process can be demonstrated and one may frequently see papillary outgrowths of mucosa surrounding an ulcerated tumor.

Ewing gives the following gross and microscopical classification:

1. Adenoma Destruens: A bulky ulcerating tumor causing obstruction, fistulae and anastomosis.

2. Stenosing Fibrocarcinoma: First produces a superficial ulcer with marked fibrotic induration. It has a tendency to be annular, causing constriction of the lumen and infiltrating tissue and nodes early.

3. Colloid Gelatinous Adenocarcinoma: Bulky, spreads rapidly and ulcerates early. This type produces miliary nodules in the peritoneum. Lymphatics are involved later.

4. Multiple carcinoma from polyposis.

5. Papillary carcinoma from single polyps.

6. Melanoma.

Colloid carcinoma or gelatinous of Ewing differs from adenocarcinoma only in that it is a degenerating form. Parhan describes it as lack of functional control of the secreting epithelial cells. This functional differentiation of cells corresponds to morphological differences seen in carcinoma cells of the acinar or columnar type. He observed colloid carcinoma in 22 per cent of all malignancies of the cecum. In our series,<sup>1</sup> with a recent pathological "check-up" of specimens, we found only 18 per cent conforming to the type.

Metastasis is rather late and recurrence is usually found at the site of origin. Death may be delayed in colloid carcinoma but the eventual mortality is greater than in other types. Parhan points out that the signet ring cells tend to be more malignant than the glandular type with columnar growth.

The most frequently involved group of lymphatic glands are the posterior colic.

<sup>1</sup> N. York, M. J., 115: 649, June 7, 1922.

<sup>1</sup> Ann. Surg., 85: 722, May, 1927.

In the Craig and MacCarty series of 100 cases studied with particular attention paid to glandular distribution, 71 per cent of all glands found were in this region, and 64 per cent of the glands showing metastatic involvement belonged to this group.

This may be explained by the frequency of involvement of the ileocecal valve in malignancy of cecum (50 per cent, Ewald, to 65 per cent, Craig), posterior wall alone in 35 per cent. When the valve was involved in the growth and regional metastases were found, the posterior colic chain showed tumor cells in 78 per cent. The surgical significance of the group is at once apparent.

Craig and MacCarty concluded: "The size of intestinal lesions and the size and number of regional lymph-glands proved to be no criterion for the presence or absence of metastasis." They found regional glandular involvement in 32 per cent of their 100 cases.

Many glands are hyperplastic, edematous and simulate malignancy, only to be found on biopsy to be inflammatory reactions. In our former series in 25 per cent we were able to demonstrate carcinomatous infiltration. Furthermore, cases which clinically are of the low malignant variety tend to have larger and more numerous hypertrophic glandular changes. When the glands are involved in the carcinomatous process clinically the picture is more severe and the prognosis as to cure much more unfavorable.

Secondary infection invades tumors early and plays a leading part in the rapidity of growth and formation of fistulae and production of peritonitis. The tumor seldom is the direct cause of death. Cachexia and the resultant death are due primarily to superimposed infective processes. This is especially true in the cecum; in this region the bacterial fermentative and putrefactive processes reach a maximum of activity. Given the seed for inflammatory reaction it follows that they will grow rapidly in gut soil

already weakened in resistance by malignant degeneration.

In the earlier communication Erdmann and Clark found regional gland metastases in 25 per cent of the reported cases. The ileocecal valve was involved in about 48 per cent of instances, and one-half of these showed lymphatic invasion. The entire wall was infiltrated in 62 per cent. Ulceration was present in about 40 per cent. Five specimens revealed infiltration of a portion of the appendix. Multiple polyps were present in 6 instances.

Distant metastases in other viscera outside of the colon were not discovered. The liver was never found to be the seat of secondary growths. This is in accord with other observers.

*Signs and Symptoms.* Seldom is the surgeon consulted in the incipency. Rarely do the symptoms manifest themselves before secondary inflammation or obstructions occur.

This fact is clearly demonstrated by our series in which the earliest duration of symptoms was given as ten days. In delving into the past history, however, the patient admitted having had indefinite pain in the right lower quadrant for four years, melena irregularly for one year, and loss of 10 to 15 pounds in weight during that period.

He appeared before me two days after an acute attack of pain, nausea, vomiting and detection of a mass 6 c.c. in diameter in the right abdomen. At operation a very extensive carcinomatous process was found. The tumor began in the cecum, involved the valve and extended into the proximal portion of the colon. The lumen was filled with ulcerated papillary projections and the entire wall infiltrated by the growth.

The longest duration of symptoms was fifteen years. This patient had complained of mild "stomach trouble" for that length of time. Three weeks previous to admission he had noticed a mass and then had consulted a surgeon. The average duration of symptoms was one and one-half years to two years.



The symptoms are actually due to secondary complications and may be divided into subjective and objective signs:

*A. Subjective Signs.* We include in this group pain, constipation alternating with diarrhea, distention, nausea, vomiting and weakness.

*Pain*, admittedly a late symptom, was present in 80 per cent of our cases. About one-half of the number maintained it to be the first indication of disease. It was described usually as a gradual onset of a dull ache. The location most often mentioned was the right side, chiefly the right lower quadrant or just to the right of the umbilicus. Radiation was inconstant, either absent or down the right leg or toward the umbilicus. Food held no relationship to it. Pain increased in severity during the night hours. Evacuation of the bowels gave the most relief. The pain, beginning gradually as a dull ache, steadily increased in character to colicky attacks and sharp piercing qualities. This development may be due to various phases of pathology, beginning with ulceration through obstruction and to the penetration of the peritoneal nerves by the tumor mass.

*Constipation*, increasing in severity, was declared the next most frequent symptom. Alternating diarrhea was mentioned in only three instances, which leads us to conclude that it is not so characteristic of cecal tumor growths as it is of tumors more distal in the colon.

*Distention, nausea and vomiting*, all signs of degrees of obstruction, occurred with about equal frequency in about one-third of the cases observed. Weakness and anorexia were present in approximately the same number.

*B. Objective Signs.* In this group we include loss of weight, presence or absence of mass, tenderness, melena, stiffening of gut, visible peristalsis and anemia.

Loss of weight was present in about 79 per cent of instances, varying in amount from 5 to 30 pounds. Associated with this there was severe weakness and anemia. The average hemoglobin reading was 69

per cent; the red cells numbered 3,900,000. About an equal number of cases showed either a corresponding diminution in the white cell count or a slight leucocytosis seldom exceeding 11,000. A mass was found in one-half of the cases, usually fixed to a degree, posteriorly. With one exception tenderness was always elicited when a mass was present.

*Melena*, a rather constant finding in tumors higher in the colon, was present in one out of 4 cases. A search for occult blood should be made, however, as we feel that a positive finding is less frequent in cecal growths.

Stiffening of the gut, excluding masses found, and visible peristalsis were noted frequently.

In addition to the foregoing signs and symptoms we have the aid of the roentgen ray. It is impossible not to regard roentgen-ray examination of paramount importance in suspected cecal disease. Unquestionably in the detection of early involvement it stands first in value as an aid in diagnosis.

In our series, in every case subjected to roentgen examination, either with the preliminary and in the vast majority of instances an accurate diagnosis was made preoperatively.

The usual findings in cecal carcinomata were a filling defect or a change in the normal contour. A lack of contrast mixture in the cecum was a frequent finding. Absence of peristalsis in the cecum with hypermotility in the colon was a very constant picture. In addition, distention of the distal loops of ileum was found with varying degrees of obstruction.

*Operation.* We prefer the Friedreich operation for tumors of the right side of the colon and consequently have followed this technique in 46 of the cases reported. It consists of the removal of 10 to 12 inches of the ileum, the entire cecum, the ascending colon and from one-third to one-half of the transverse colon, completed by an anastomosis of the ileum to the transverse colon, end-to-end being the choice. A side-to-side anastomosis is the

operation of choice in the very fat endowed colon. End-to-side anastomosis was done in 3 of the recorded cases.

In the previously reported cases we had not had occasion to use the methods of precaution against gas distention as advocated by Dr. Charles Mayo. In the past four years I have made an enterostomy in several cases.

Results following the Friedreich technique have justified our preference for it. Of the 28 cases previously reported we had 6 deaths, or a mortality of 21.4 per cent. The postoperative convalescence was relatively easy, and the follow-ups were satisfactory.

Ileocolostomy was resorted to on 5 occasions, 2 with anastomosis of the ileum to the transverse colon and 3 of the ileum to the sigmoid. One patient had had an ileosigmoidostomy made six months previously which was not disturbed at the second operation when removal of the growth was done. On three occasions the growth was not resected; only a palliative short circuit was attempted. There was one recurrence in a patient from another city, producing obstruction two years after operation, in whom an ileosigmoidostomy was done.

A delivery of the tumor after the method of Mikulicz and subsequent closure of the artificial anus resulted in one death out of 2 cases.

Four instances of complete intestinal obstruction rendered resection impossible and a temporary ileostomy was made with a Paul's tube inserted into the ileum, resulting in two deaths.

A plastic on the cecum with local resection of a benign tumor was done in one instance and resulted in permanent cure. This is not added to the total number.

We were unable to find the type of operation done in one case with carcinoma complicated by obstruction which resulted in a mortality. In two instances appendectomies had been done within a period of five years and both patients stated that they had not been feeling well since

that time. At operation in each instance the growth was very extensive. This might suggest the possibility of an early tumor presenting the symptoms of an inflamed appendix and having been overlooked. Attention to such has been cited by myself in a previous communication.

Another patient had had a resection of a portion of the transverse colon eight years before and was entirely well until six months before I saw him. At operation an extensive colloid carcinoma was found with regional glandular metastases. Moreover, in the colon, 49 cm. from the cecal growth, a nodule  $25 \times 10$  mm. was found to be of similar pathology. Here again, since we know that colloid carcinoma is sluggish in growth, we may infer that the cecal tumor might have been present and passed unnoticed by the operator.

#### SUMMARY

Seventy operated cases of cecal tumor are studied in this report. Carcinoma was found in 56 instances, tuberculosis in 9, chronic inflammation in 2, lymphosarcoma in one, polyposis in one and one of undetermined pathology.

Other tumors occasionally found are cyst, gummas, lipomas, tuberculomas, papillomas, cholestyctomas, liomyomas and actinomycoses.

The ileocecal region is the site of predilection for tuberculosis because of the right lymphatic supply.

Five of the 9 tuberculosis cases were of the hyperplastic type without a demonstrable primary focus. One had an involvement of the right lung and the cecal growth was considered to be secondary. Three others were tuberculomas.

The Friedreich resection was performed in all the tuberculous tumors with no mortality and a symptomatic cure. Only an appendectomy was done in 3 tuberculomas.

The cecum has a predisposition to malignant degeneration because of its physiological and anatomical relationship.

Regional glandular metastasis was found in 25 per cent. of the cases previously reported. The ileocecal valve was involved in 48 per cent.

The signs and symptoms most frequently found were pain, loss of weight, a mass and marked anemia. Roentgen examination was the most accurate aid in diagnosis.

The Friedreich operation was the method of choice, being performed in 47 of the 56 cases of carcinoma, with a mortality of 21.4 per cent. in 37 cases reported previously. Of 22 cases since January, 1927, 12 were male, 8 were female and 2 of sex not recorded.

#### CONCLUSION

Carcinoma is the most frequent cecal tumor requiring surgical intervention. Lymphosarcoma is the most highly malignant tumor.

Cecal carcinomata are slow growing and only moderately malignant. Secondary infection invades the tumor early and is the chief cause of the profound cachexia found in these cases.

Distant metastases are rare in carcinoma of the cecum.

Secondary intestinal growths are not uncommon and should always be sought for. A malignant tumor obstruction may simulate a chronic appendicitis.

#### BIBLIOGRAPHY

- SISTRUNK, W. E. Carcinoma of caecum and ascending colon. *S. Clin. N. America*, 5: 725-729, 1925.
- SEVAN, T. S. Case of lymphosarcoma of caecum. *Radiology*, 5: 71072, 1925.
- HAGYARD, C. E. Lympho-sarcoma of appendix and caecum. *Northwest Med.*, 24: 342-344, 1925.
- HUMISTON, C. E., and PIETTE, E. C. True cholesteoma fo caecum. *J. A. M. A.*, 84: 874-876, 1921.
- JOYCE, T. C. Carcinoma of the caecum. *S. Clin. N. America*, 4: 1337-1338, 1924.
- PODALKA, J. Leiomyoma of the caecum. *J. A. M. A.*, Abstract, 82: 1962, 1924.
- CRAIG, McK. W., and MACCARTY. Involvement of lymph glands in cancer of the caecum. *Ann. Surg.*, 77: 698-710, 1923.
- PIERSOL. Human Anatomy. Ed. 7, Phila., Lippincott, 1919, pp. 115-123.
- GRIFFETH, F. W. Actinomycosis of the caecum. *Surg., Gynec. Obst.*, 33: 538, 1921.
- HINGLAIS, M. Adenomyosis of the caecum and appendix. *Intern. Clin.*, 3: 59, 1921.
- HARTWELL, J. A. Non-tubercular inflammation of the caecum. *S. Clin. N. America*, 1: 361, 1921.
- READ, W. D. Tuberculosis of the caecum. *Northwest Med.*, 20: 282, 1921.
- EWING, J. Neoplastic Diseases. Ed. 2, Phila., Saunders, 1922, p. 661.
- MAYO, C. H., and HENDRICKS, W. A. Carcinoma of the right segment of the colon. *Ann. Surg.*, 83: 357, 1926.
- CHOYCE, C. C. System of Surgery. N. Y., Hoeber, 1923, 1: 523.
- PARHAN, D. Colloid carcinoma. *Ann. Surg.*, 77: 90-105, 1923.
- MENZIES, C. S. Tuberculosis of ileo-caecal region with special reference to the caecum. *Northwest Med.*, 21: 406, 1922.
- COFFEY, *Internat. Clin.*, 4: Sec. 31, 1921.
- MUMMERY, J. P. L. Diseases of the Colon. N. Y., Wood, 1910, p. 322.
- BROWN, L., and SAMSON, H. L. The early roentgen diagnosis of ulcerative tuberculous colics. *J. A. M. A.*, 73: 77-85, 1919.
- ARCHIBALD. *Am. Rev. Tuberc.*, pp. 433-449, October, 1917.
- READ, W. D. Caecal pathology. *Northwest Med.*, 20: 11, 1921.
- ERDMANN, J. F., and CARTER, R. F. Malignancies of the colon. *N. York M. J.*, 115: 649, June 7, 1922.



# FASCIAL TRANSPLANTS FOR CLOSURE OF THE ORIFICE OF UMBILICAL HERNIA\*

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THERE have been many operations devised for the closure of the orifice of umbilical hernia, most of which Utilization of a fascia lata transplant, placed according to the method herein illustrated, avoids tension and insures per-

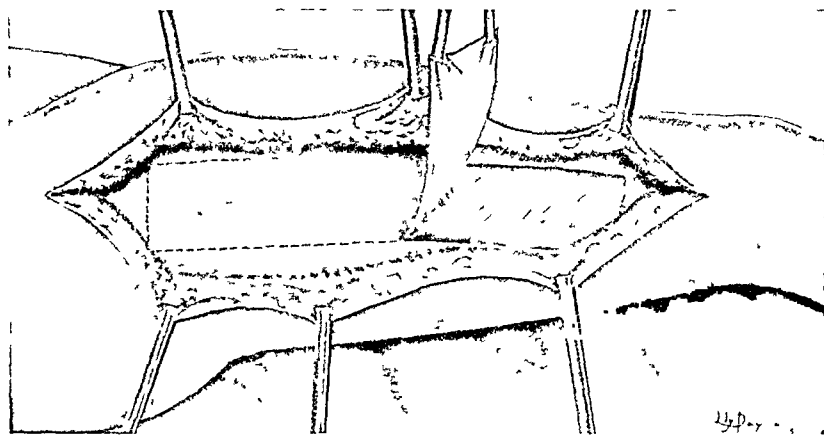


FIG. 1. Incision in thigh for removal of a piece of fascia lata  $1\frac{1}{2}$  inches wide and 8 inches long.

are characterized by overlapping of the fascia of the abdominal wall. If this can be done in such a way as to avoid tension on the line of sutures, the operation is likely to be followed by cure.

It is idle, however, for surgeons to claim that the results following this method of procedure are uniformly successful. If patients are examined one to five years following operation, there will be found a great many "recurrences"; and at the second operation, the edges of the fascia which have previously been sutured will be found widely separated.

The use of fascial transplants sutured properly in the canals and orifices of hernias of large-size and difficult to cure is now recognized as a valuable contribution to the technique of operations for hernia in all parts of the abdomen and is extensively employed. The experimental work of Gallie several years ago demonstrated the permanency of such grafts.

The illustrations show the method without further description. I have employed this method in many cases and now long enough to be sure of final results. The method seems to fulfill the fundamental requirement of adequate closure with tissue grafts, sutured into accurate position without tension, and is submitted to surgeons as a better method than simple overlapping.

A piece of fascia lata at least  $1\frac{1}{2}$  inches wide and 8 inches long is removed by the usual incision in the thigh. This piece of fascia is cut into two equal pieces, each  $1\frac{1}{2}$  inches wide and 4 inches long. These are kept in salt solution until ready to be sutured into place.

A skin incision transverse and elliptical in shape is made through the skin and fat of the abdominal wall down to the fascia, covering the recti muscles, the fat is brushed from the fascia for a distance of 2 or 3 inches around the hernial orifice, and

\* From the Department of Surgery of the Medical College of Virginia. Submitted for publication July 10, 1931.

the neck of the peritoneal sac is exposed and opened. Bowel and omentum if adherent to the sac are freed, all points of possible

ever, it can then be sutured in a transverse direction, and the fascia transplant made in the space between the peritoneum and

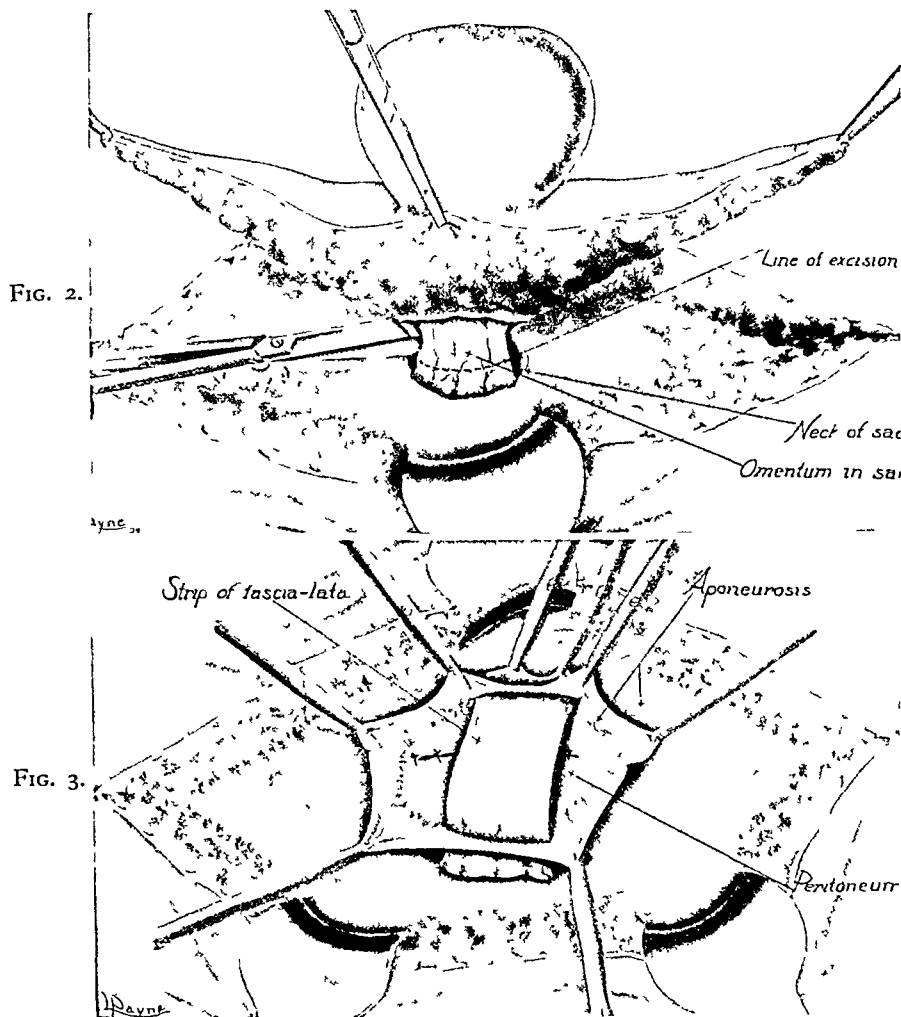


FIG. 2. Removal of umbilical hernia containing incarcerated omentum. Transverse incision, omentum ligated, and sac being excised. Omentum will be cut across at dotted line.

FIG. 3. Excess of sac has been removed, omentum drawn back, peritoneum closed. One patch of fascia lata in position to be sutured.

bleeding are ligated, and returned to the abdominal cavity. If necessary, the fascia forming the hernial orifice may now be divided on each side in a lateral direction. Frequently, however, this is unnecessary. The peritoneum about the margin of the orifice, if not too thin, may be gently separated from the overlying fascia. Usually the peritoneum is so thin that to attempt to separate it causes tears of the peritoneum. If it can be separated, how-

the deep fascia. I have in some cases allowed the peritoneum and fascial layers to stay together, and put the fascia transplants in position under the peritoneum. In either case, the two transplants are placed in position as indicated in Figure 4 through a separate cut an inch or more beyond the margin of the orifice, the ends of the transplant are drawn through and sutured in position. This makes an adequate closure of the orifice with two patches

of fascia, placed in opposite directions, like a cross. The skin edges are then sutured.

I have had the opportunity to examine

was that of a tremendously obese woman in whom there occurred some wound infection followed by a draining sinus.

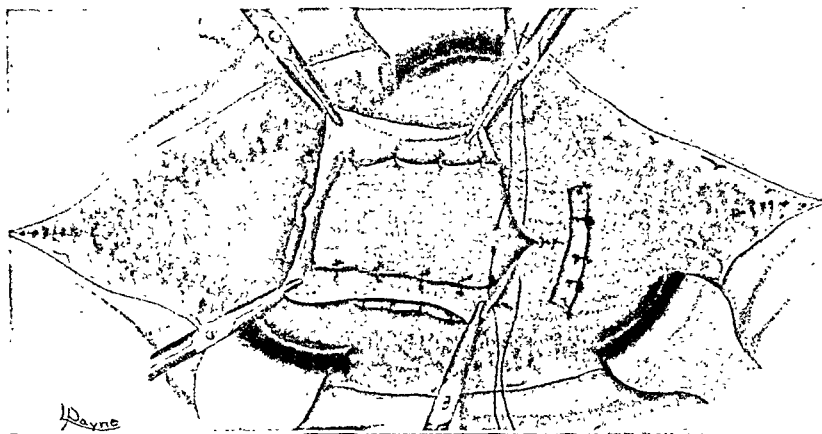


FIG. 4.

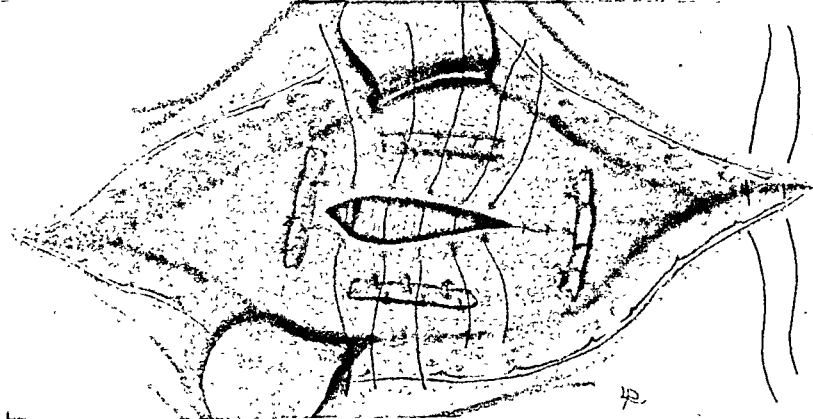


FIG. 5.

FIG. 4. Second patch of fascia lata has been put in position in a direction opposite to the first, and fibrous portion of remainder of sac is being sutured.

FIG. 5. Both pieces of fascia lata are sutured in place and fibrous part of remainder of sac is sutured over fascia lata.

2 cases which served as good tests for the efficiency of the operation. One woman operated upon while three months pregnant went through the remainder of pregnancy and normal labor, without recurrence of the hernia. The other case

Eights months following operation the sinus was excised; three silk sutures were removed. This gave opportunity to inspect the field of operation, where it was found that the fascia patches were firmly intact, and no hernia recurrence.



# THE IMPRACTICABILITY OF USING FASCIA FOR THE GRADUAL OCCLUSION OF LARGE ARTERIES\*

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**A**N ideal method for the progressive obstruction of the great vessels has never been achieved. At first clamps

Neff clamp<sup>8</sup> and by tapes, ligatures, strips of fascia, pieces of aorta, or Baer's membrane. The disadvantage of this procedure

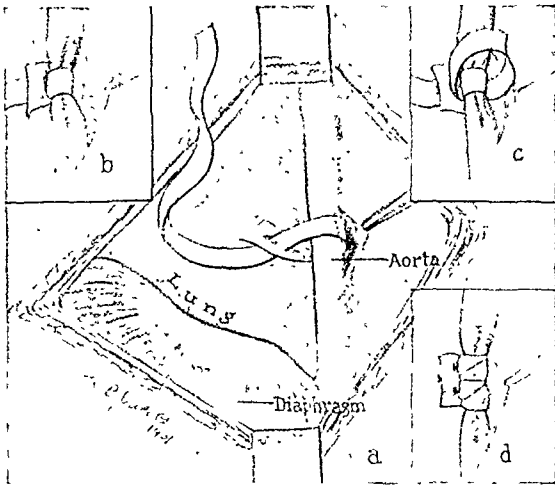


FIG. 1. Method of applying fascia to thoracic aorta. *a.* Strip of tissue is placed beneath vessel and threaded through a slit in one end. *b.* It is pulled tight to obtain desired amount of constriction. *c.* Successive turns are taken by passing strip through slit at each revolution. *d.* After six or eight turns have been placed, two ends are fixed by silk sutures. Care is used to prevent sutures from coming in contact with arterial wall.

or snares, which protruded from the wound were used. These usually resulted in the formation of an infected sinus with occasional secondary hemorrhage. Halsted<sup>2</sup> devised the first aseptic method and with the exception of its use on the aorta, his partially occluding aluminum band is the best device today. The methods proposed attempt to accomplish the object in three ways. First, by exerting pressure on the outside of the vessel wall. This is done by the Halsted band, the Matas band<sup>5</sup> the

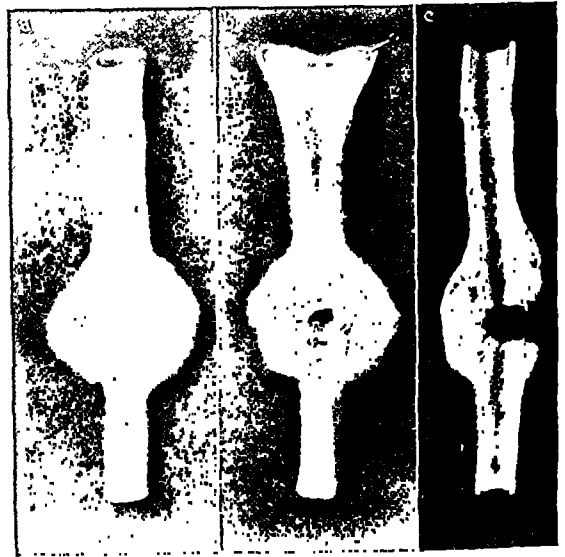


FIG. 2. Rupture of thoracic aorta ten days after application of a partially obstructing fascial band. *a.* Mass of connective tissue which surrounds vessel. *b.* Opposite side showing nearly complete absence of continuity of lumen. *c.* Longitudinal section to show attenuated wall at site of constriction.

is that the thrust of the expansile pulsation pushing against the compressing device weakens and may rupture the vessel. Second, by plicating the arterial wall with sutures at successive operations. Matas and Allen<sup>5</sup> and Reid<sup>10</sup> have tried this method. Its disadvantage is that with disease of the vessel the sutures do not hold well. If they tear out hemorrhage results. Third, by obstructing the lumen from within. A method has been proposed<sup>9</sup> for inducing gradual thrombosis by means of a coiled spring which is screwed into

\* From The Department of Surgery, The University of Rochester School of Medicine and Dentistry.  
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the lumen. Reid<sup>10</sup> has advocated a fascial plug with a tube in its center which is placed within the artery. The disadvantages of these methods are the possibility of hemorrhage at the time the vessel is opened and the danger of peripheral embolism. The latter has never been observed but is a theoretical possibility. It is felt that the aorta can best be occluded by some sort of internally obstructing device which does not place a strain upon the vessel wall.

Since an ideal method for gradual occlusion of the large arteries has not been achieved, continued experimentation on the subject is desirable. It is conceivable that the universal property of scar tissue to contract could be put to use here. If after first partly constricting the vessel at operation, enough scar contracture could be induced, complete obstruction would result. This process might be tested by encircling the artery with large amounts of fascia in the hope of producing fibrosis. Past experience with the use of fascia as a partially occluding agent has been disappointing. It was first tried by Halsted<sup>2</sup> and Nasseti<sup>7</sup> working independently. Halsted says:

Fine silk cut through in two days; coarse silk cut through more slowly, knotted ligatures were found to be unsuitable, for a desired degree of constriction or obliteration could not be accurately obtained nor could the crushing of the arterial wall be invariably avoided. Tapes of various materials were tested—of cotton, of chromicized intestinal submucosa, of elastic tissue obtained from the aorta, of aponeurotic white fibrous tissue. These were applied in spiral or cuff form.

These tissue bands always relaxed and allowed reestablishment of the lumen. Brooks<sup>1</sup> tied the human aorta with fascia lata and at autopsy three months later found that it had relaxed. McNealy and Lichtenstein<sup>6</sup> have advocated attaching the fascia to muscles on each side of the vessel. Reports by Hitzrot,<sup>4</sup> Hanford and Wheeler<sup>3</sup> and Scheffelaar-Klots<sup>11</sup> discuss the use of tissue bands for partial occlusion

of the large arteries. It has been the usual experience that one or two turns of fascia about an artery always relax to allow re-



FIG. 3. Erosion of arterial wall at site of contact with a silk stitch. Halsted reports a similar experience.

establishment of the lumen. It was hoped that by using multiple turns about the vessel enough periarterial support would be obtained to prevent relaxation and even to increase the constriction by fibrotic contracture. Consequently the aorta of dogs was encircled and partially constricted by six to eight turns of heavy fascia. This gave a mass of connective tissue about the vessel. It was found that even this relaxed and in some cases it so weakened the wall that rupture followed. Thus fascia is not only unsatisfactory as a partially occluding agent but also is potentially dangerous in its effect.



## METHOD

Adult dogs which received  $\frac{1}{4}$  grain of morphia and ether anesthesia by tracheal insufflation were used as test animals. At first the fascia was obtained from the anterior rectus sheath but later the material was taken from the tendon of the erector spinae muscles. A strip  $\frac{1}{2}$  inch wide and 6 or 7 inches long was excised. After all fat, muscle and areolar tissue had been removed, a slit was made about  $\frac{3}{8}$  inch from one end. Having prepared the fascia in this manner, it was wrapped in moist gauze, the wound was closed and the primary operative procedure was done. In ten of the animals the thoracic aorta was occluded while in six the abdominal portion below the renal arteries was obstructed. The thoracic aorta was exposed through an intercostal incision in the eighth left interspace. After opening the chest the parietal pleura was incised and the vessel picked up. The strip of fascia was passed beneath it and the end was threaded through the slit in the opposite end (Fig. 1 A). It was pulled tight enough to obliterate the peripheral pulse while leaving a faint thrill on the distal side (Fig. 1 B). This tension was maintained and the successive turns about the vessel were taken by passing the strip through the slit at each revolution (Fig. 1 C). After six or eight turns the ends were fixed with silk sutures (Fig. 1 D). The abdominal aorta was exposed through a muscle splitting incision in the left flank. After the peritoneum was opened the kidney was picked up and tension made on the renal artery. This gave a guide to the aorta which was freed by retroperitoneal dissection. After the vessel had been isolated it was partially obstructed by fascia in the same manner as was the thoracic portion.

The animals that survived were sacrificed in from one to four months after operation. The entire arterial tree was injected with a suspension of 20 per cent barium sulphate in 10 per cent gum acacia through the carotid artery after exsanguination. The

animals were placed in a refrigerator for six hours to allow the injection mass to harden. The thoracic and abdominal viscera were then removed and roentgenograms made of the somatic arteries. The operative specimens were removed and examined. In this way evidence of the condition of the lumen was obtained by roentgenographic and pathological examinations.

## RESULTS

In all sixteen dogs were operated upon. Three died within twenty-four hours of operation from too sudden obstruction of the thoracic aorta. These animals are included because they represent one of the disadvantages of using fascia. With a pliable, plastic, substance such as tapes, ligatures or tissue strips it is difficult to judge the degree of constriction of the vessel. Pathological examination of these animals showed that insufficient opening had been left in the aorta for preservation of life. To overcome this disadvantage the fascia was pulled tight onto small rods which were removed after the tissue was fixed with sutures. But it was found that the character of the thrill distal to the obstruction was the best guide to the degree of obstruction. With rigid substances such as aluminum bands the amount of constriction can be judged more accurately.

In four of the sixteen animals rupture at the site of the constriction occurred. Three of these had the fascia applied to the thoracic aorta and one to the abdominal portion. The rupture occurred in one animal on the seventh postoperative day, in two on the tenth and in the one on which the abdominal aorta was used on the seventeenth day. A drawing of one of the specimens where rupture occurred on the tenth day after operation is shown in Figure 2. In two of the animals rupture occurred at the site of contact of a silk stitch with the vessel wall. Such a specimen is shown in Figure 3. This experience serves to illustrate the danger of allowing the arterial wall to be repeatedly thrust against an unyielding object like the knot

of a suture. But even where the vessel did not rupture its wall was weakened at the site of the constriction. A longitudinal sec-

Examination of the remaining nine animals revealed the following. In one month the fascia had partially relaxed.

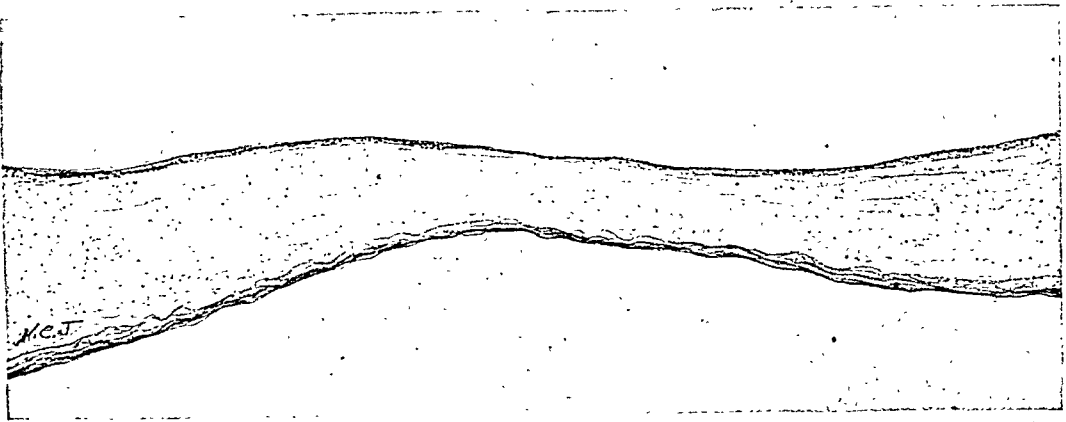


FIG. 4. Longitudinal section of aorta one month after application of a partially obstructing fascial band. Atrophy of wall is evident. Magnified twelve times.

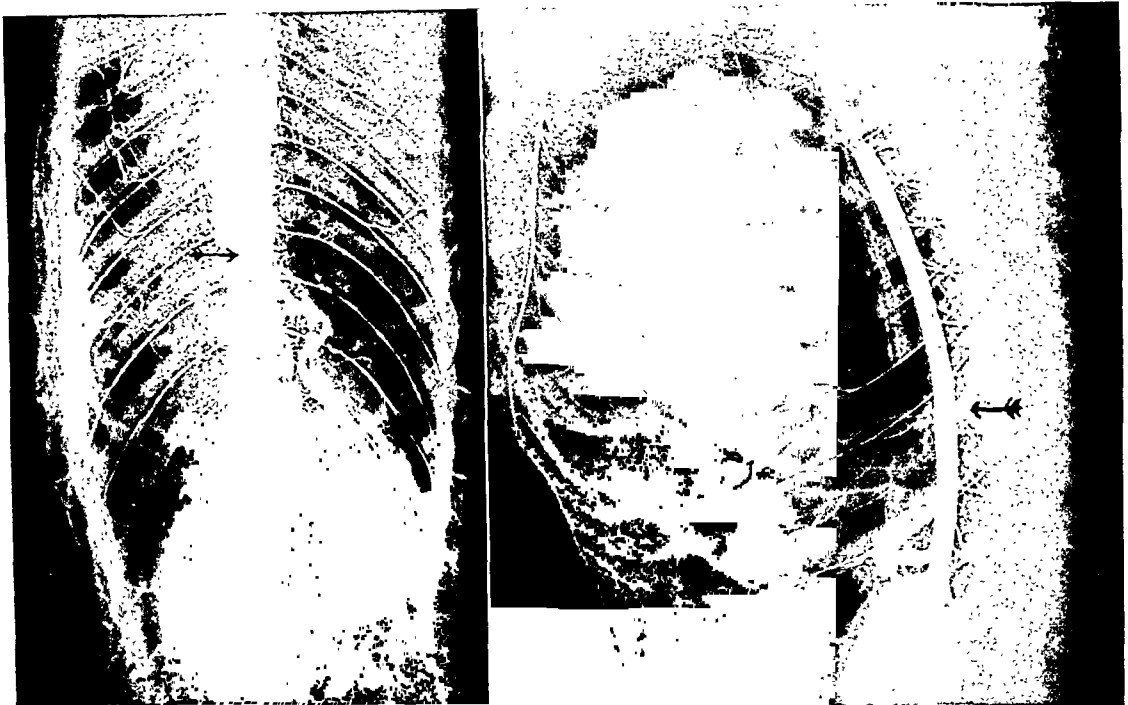


FIG. 5. Anteroposterior and lateral views of x-ray injection specimens of thoracic aorta three months after constriction with a tissue band. Lumen has completely reestablished.

tion of the aortic wall after one month's pressure from a tissue band is shown in Figure 4. Here it will be seen that the expansile thrust with each pulse beat against the constricting device has caused atrophy of the vessel wall. The mechanism of rupture is evident.

In two months it had usually completely relaxed though in some instances there was evident a slight amount of constriction. In three months it was always relaxed and partly resorbed. An x-ray injection of such a specimen is shown in Figure 5 where it will be seen that the lumen is reestab-

lished. In four months not only was the fascia relaxed but much of it had been resorbed. This condition is illustrated in



FIG. 6. Caliber of vessel has returned to normal and much of fascia has been absorbed four months after operation.

Figure 6. From these results it is seen that even when multiple turns of fascia are placed about a large artery restitution of the caliber of the vessel invariably occurs. Rather than having an increase in the constriction of the artery from fibrotic contracture there was resorption of the tissue band.

#### SUMMARY

1. A method of partial occlusion of arteries with six to eight turns of heavy fascia was attempted. This amount of connective tissue was used in the hope of inducing enough scar tissue contracture to complete the obstruction.

2. This method was used on the thoracic aorta of dogs in ten experiments and the abdominal portion below the renal vessels in six instances.

3. With a plastic substance such as tissue strips it is difficult to judge the degree of constriction. Because of this three animals were killed by too great obstruction of the thoracic aorta.

4. In four instances the arterial wall atrophied and ruptured at the site of the constricting device. Rupture occurred in from seven to seventeen days after operation.

5. In the remaining nine experiments relaxation of the fascia invariably occurred. Restitution of the caliber of the lumen was partial in one month and complete in from two to three months. Resorption of the tissue bands occurred in from three to four months.

6. The results of these experiments permit the conclusion that fascia is an unreliable and somewhat dangerous material to use for partial occlusion of the great vessels.

#### REFERENCES

1. BROOKS, B. Ligation of the aorta. *J. A. M. A.*, 87: 722, 1926.
2. HALSTED, W. S. The partial occlusion of blood vessels, especially of the abdominal aorta. *John Hopkins Hosp. Bull.*, 16: 346, 1905.  
Partial occlusion of the thoracic and abdominal aorta by bands of fresh aorta and of fascia lata. *Tr. Am. Surg. Ass.*, 31: 218, 1913.  
Partial, progressive and complete occlusion of the aorta and other large arteries in the dog by means of the metal band. *J. Exper. Med.*, 11: 375, 1909.
3. HANFORD, J. M., and WHEELER, J. M. Pulsating exophthalmus. *Ann. Surg.*, 92: 8, 1930.
4. Hitzrot. Quoted from Wheeler, J. M. Pulsating exophthalmus. *Atlantic M. J.*, 31: 812, 1928.
5. Matas, R., and Allen, C. W. Conclusions drawn from an experimental investigation into the practicality of reducing the caliber of the thoracic aorta by a method of plication or infolding of its walls by means of a lateral parietal suture applied in one or more stages. *Tr. Am. Surg. Ass.*, 31: 196, 1913.  
Occlusion of large surgical arteries with removable metallic bands to test the efficiency of the collateral circulation. *J. A. M. A.*, 56: 253, 1911.
6. McNEALY, R. W., and LICHTENSTEIN, M. E. A study of arterial occlusion by means of autogenous fascial strips. *Surg. Gynec., Obst.*, 47: 99, 1928.

[For remainder of References see p. 252.]

# THORACOPLASTIC SURGERY IN CHRONIC TUBERCULOSIS WITH ASSOCIATED EMPYEMA\*

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THE occurrence of empyema in the course of advanced pulmonary tuberculosis initiates a grave era with a hopeless outlook ordinarily, unless radical thoracoplastic procedures can be early instituted, which unfortunately are so often not feasible in this impoverished group of patients. The following case well illustrates the frail physical specimens that commonly confront us in this surgical field, and the extent of graded operative work that oftentimes becomes necessary to reclaim these relative derelicts:

E. Y., a thin anemic married woman, poorly developed, aged thirty-eight, claimed good previous health save for frequent colds for several years, and contact with a tuberculous brother. The onset of her tuberculosis dated back to May 1926, when she failed to weather one of her so-called colds. Temperature and productive cough persisted with increasing loss of weight and strength; she became hoarse and had pleuritic pains in left chest. A small hemorrhage soon occurred. Patient continued a downward course, and was admitted to County sanatorium in January, 1927, with advanced involvement of left lung and upper lobe cavitation, but contralateral lung was good except for some activity at the apex. She was in poor condition, quite toxic and the outlook was unfavorable under conservative regimen.

Artificial pneumothorax was wisely started without delay and satisfactory compression was soon obtained with resultant clinical improvement which slowly but steadily continued, and by the following summer the patient was markedly improved, sputum negative. She became semiambulatory in October with no cough or expectoration, had mostly regained strength and 6 lbs. in weight, and condition was good. Hemoglobin 75 per cent, R.B.C. 4,000,000, pulse 90, B.P. 120/78.

In November, 1927 she developed a small pleural effusion, which markedly increased by the end of the month, and aspiration became necessary to relieve the cardio-respiratory embarrassment incident to fluid. December found her running an irregular septic temperature with repeated aspirations necessary to keep down the serous tuberculous exudate; the following month revealed conditions becoming worse, temperature high, patient quite septic and the fluid became purulent.

In February, 1928, a low thoractomy was performed with evacuation of large quantity of thick foul pus, and tube was inserted for drainage. This resulted in a brief period of improvement, but the patient was seriously ill and toxic till late spring of this year, and required three blood transfusions to tide her over this period. The pleural cavity was irrigated with Dakin's solution for a while till the presence of a bronchial fistula became evident, after which bland solutions of aniline dyes, acriflavine, salt, etc. were used but with desultatory results. Pus was negative for tubercle bacilli repeatedly but showed various cocci and some gram-positive bacilli.

The patient improved during the summer and fall, the upper portion of the left lung had reexpanded and the empyema cavity was much smaller, holding little over 300 c.c.; there was drainage of 30 to 60 c.c. of thick pus daily. Toward the end of the year her condition was such that a three-stage thoracoplasty, extrapleural, was believed advisable; sedimentation rate 20, hemoglobin 65 per cent, W.B.C. 11,600, polymorphonuclears 79 per cent, pulse 100, B.P. 104/80.

Ribs 4 to 11 were resected posteriorly (4 inch segments) in two stages, January 22 and February 19, 1929 under nitrous oxide. The patient stood the operation well except that the pulse became quite weak and rapid after the second procedure. She seemed to be decidedly benefited for several months. Alpine light was applied to the side, and because the

\* Read before the Los Angeles Surgical Society, October 9, 1931.

disease was quiescent in the lung and the cavity reduced in size (200 c.c. capacity), further surgery was postponed with the patient

multiple small stages could be attempted according to her physical response, although she was far from a good risk. Her hemoglobin



FIG. 1.

FIG. 2.

FIG. 3.

FIG. 1. Tuberculosis of left lung, Jan. 7, 1927.

FIG. 2. Left pyopneumothorax February, 1928, after one year of artificial pneumothorax.

FIG. 3. Extensive resection of left chest later necessary because of very thickened pleura and rigid chest wall (sequel to partial Sauerbruch thoracoplasty early in 1929).

better than for many months, and further improvement was expected in time. Pleural discharge increased late in the fall, and she had an occasional rise of temperature, and at the end of another year she had again lost some, when it was decided that additional collapse was necessary for the remaining pleural cavity and sepsis.

December 30, 1929 I first saw this patient in consultation relative to further thoracoplastic work, but did not consider this advisable unless she could be built up, her weakness and poor physical condition with considerable anemia and low cardiac reserve being the deterrents. Her hemoglobin was 55 per cent with 3,200,000 R.B.C., pulse 110-120, with B.P. 100/78 and she showed the effects of her prolonged toxemia; vital capacity 1150 and sedimentation rate 17. Discharge from empyema averaged 60 c.c. heavy pus. She was kept outdoors, placed on an anemic diet with large doses of Blaud's pills, and various non-irritating solutions were used in an effort to minimize her pleural absorption, but the return of cough because of the open bronchus soon interdicted all irrigations and topical medication was then used.

The latter part of April 1930 I was surprised to find that she had improved, so surgery in

at this time was 62 per cent, sedimentation rate 21, pulse in the 90's and B.P. 104/60. On April 29, the upper three ribs were resected widely paravertebrally and also the regenerated segment of the fourth. Nitrous oxide anesthesia was used. Convalescence was uneventful save for several days with rapid pulse and vomiting.

On June 18 a parasternal resection of the second to sixth ribs (3 to 4 inches) was performed; intravenous sodium amytal was used at this stage as well as the next three, together with novocaine blocking of the intercostals. She stood this operation surprisingly well. The small sinus opening had become narrowed, as the cavity was now much smaller and drainage was inadequate, so on July 22 the sinus was laid widely open by removing scar tissue and thickened parietal pleura; the sinus extended downward ending blindly around the eleventh rib posteriorly, and also upward beneath the scapula to the sixth rib. The wound was left widely open. Except for pain and gastrointestinal upset, the patient suffered no ill effects from this procedure; suppuration soon diminished under visual medication but she did not improve through the hot weather, and in the middle of August she was given a transfusion to boost her strength and for her con-

tinued toxic anemia (hemoglobin 54 per cent which promptly increased to 70 per cent).

On October 7 and 28 the regenerated ends and axillary segments were resected (3 to 4 inches) of the seventh to eleventh ribs, and the empyema cavity was unroofed over this area by excision of  $\frac{1}{2}$  inch thick parietal pleura and adherent scar. The patient had a week of nausea and vomiting after the latter procedure, and her come-back at this time was quite slow, and early in December she was given another transfusion which benefited her decidedly. The bronchial fistula was still open at the apex of the cavity, but there was a scant amount of suppuration. Alpine lamp and heliotherapy (when practicable) were given into the cavity, which was packed with Bipp for a while without much improvement.

March 7, 1931 a posterior shelf overhanging cavity due to the posterior ends of fifth, sixth, and seventh ribs were resected (2 inches) with overlying pleura and scar. This procedure did not seem to set the patient back any. The pleural cavity began to look healthy towards the end of the month, was irrigated with a weak solution (1:1000) of bismuth-violet, and lightly packed with this dye in a 25 per cent alcoholic solution in strengths varying from 1:100 to 1:500. Cultures showed the cavity to be sterile by the middle of May, and as the patient was in a fair condition, a plastic closure was done under ethylene on May 27. An atrophied latissimus dorsi muscle was the only available structure to fill the remaining  $4\frac{1}{2} \times 2 \times \frac{1}{2}$  inch cavity, and after superficial decortication of the visceral pleura a large pedicle of this muscle was freed to its attachment to the inferior angle of the scapule and implanted into the cavity and over the fistu-

lous opening with chromic sutures, and overlying soft tissues were approximated with rubber tissue drains inserted down to the pleura. A small area was left at the inferior portion as the extreme thinness and scant musculature of this patient afforded little adjacent structures for an ideal plastic closure. It was hoped the overlying soft tissue would form a scar in this small space.

The patient is improving slowly but progressively; color is good, there is no cough or dyspnea, pulse 90, B.P. 106/78. Appetite is good; she is semiambulatory.

The small area has decreased in size, but cultures showed skin cocci during the summer; discharge was negligible. The area was sterilized with violet dye as previously, and as its obliteration by nature appeared rather remote (if ever) from the progress made since May, the first of last week it was closed by dissecting soft tissues well back, freshening its scarred walls, implanting a small section of scarred dorsalis spinae muscle into the area and approximating the adjacent soft tissues.

This woman has had a very stormy siege with multiple operations because of her markedly lowered physical condition, which safely permitted little surgery at any one sitting, and her early partial thoracoplasty, which had to be done over, with bony regenerations and scarred thoracic wall, made later operative work more difficult and shocking, and prolonged the period of surgical work quite materially.

The patient weighs 110 lbs. now; vital capacity is 950, pulse 80 to 90; she feels well and is improving. It is believed that another six months will find her markedly better and in surprisingly good condition in spite of her deformity and physical handicap.



# NON-PARASITIC CYSTS OF THE SPLEEN

WITH REPORT OF A PATIENT SUCCESSFULLY OPERATED UPON\*

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NEW YORK

CYSTS of the spleen are rare. Osler stated that he had seen only two in his own practice, one of which no symptoms and are found either at autopsy or in the course of operations for other conditions within the abdomen,

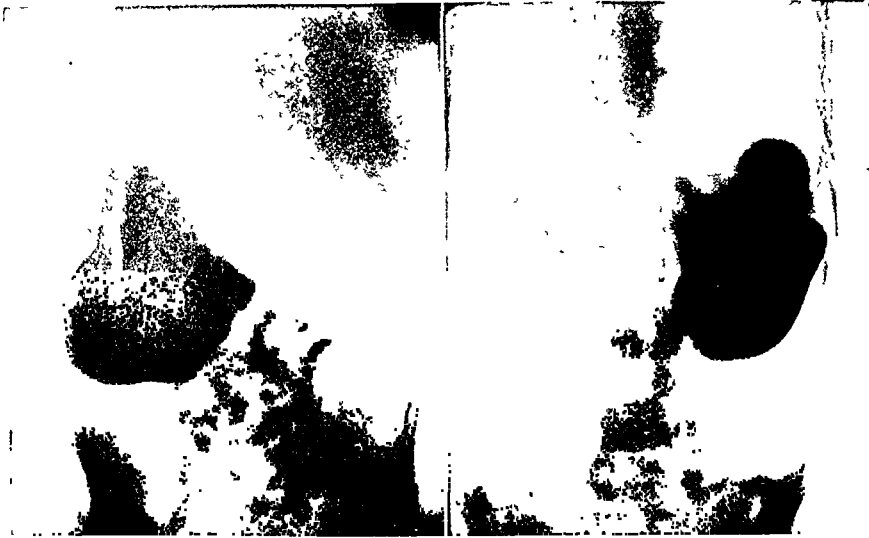


FIG. 1. Before operation showing displaced stomach.

FIG. 2. After operation showing stomach returned to its normal position.

was an echinococcus cyst and the other a serous cyst of the hilus. Ziegler in his "Pathology" made no mention at all of splenic cysts. Novak classifies them as follows: (1) Dermoid cysts (extremely rare). Only 2 cases have been recorded. (2) Parasitic cysts (echinococcus). These are commonly associated with other similar cysts in other parts of the body. (3) Non-parasitic cysts: (a) traumatic; (b) inflammatory; (c) degenerative cysts; (d) dilatation cysts; (e) neoplastic cysts.

Non-parasitic cysts only will be discussed in this article. While the literature is still scanty the number of cases reported by surgeons has increased considerably in the last decade, especially cases of large cysts which produce definite symptoms. Those of small size which cause

are of no clinical interest. The simplest classification of these non-parasitic cysts seems to me to be that of Calloust. He distinguishes the hematogenous or hemorrhagic cysts sometimes called pseudocysts and the true cysts which always have an endothelial lining. The former hold the chief interest for the surgeon as they are by far the more common and on account of their much larger size are the ones that produce clinical symptoms. These large cysts are always single and of regular outline. They have occurred more commonly in women and most frequently between the ages of twenty and fifty.

Etologically these large non-parasitic cysts result from a hemorrhage caused by rupture of the capsule of the spleen and

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the formation of a hematoma which becomes encapsulated by the production of a fibrous envelope. They are therefore superficial to the spleen or perisplenic. The cause of the extracapsular hemorrhage and cyst formation is not always clear. Out of 17 cases collected by Bryan, there was a history of traumatism in 8, and of malaria in 7. It is possible that the tense capsule of an enlarged malarial spleen may give way causing hemorrhage followed by encapsulation. In the case that I am reporting there was no history either of traumatism or malaria. In the traumatic cases the history of injury may precede that of the appearance of the cyst by a long period. In Cr  d  's case the interval was ten years.

The pathological examination of the cyst wall shows dense fibrous tissue with no endothelial lining. The cyst which is always unilocular contains a sanguineous or sero-sanguineous fluid with disintegrated blood cells and debris. The contents vary in amount from 2 to 8 liters. The cyst wall may become thick and adherent to surrounding structures, particularly the omentum, stomach and diaphragm. The symptoms of the type of cyst under consideration are variable, and not characteristic. There may be no symptoms whatever until the cyst has become of such a size as to produce pressure on or adhesions with adjacent structures. There may be local discomfort in the left hypochondrium, or actual pain local or radiating. *X-ray* may show a shadow in the left hypochondrium. A gastrointestinal series proved of great diagnostic value in my case as it showed marked displacement of the stomach downward and to the right, which pointed very strongly to pressure from an enlarged spleen or splenic tumor. Palpation may give a feeling of fluctuation.

The treatment is entirely surgical. Splenectomy is the operation of choice. Incision and drainage is an unsatisfactory method. It means a prolonged or even permanent fistula followed by possible secondary operation. Excision of the cyst is neces-

sarily associated with considerable hemorrhage and is hence more dangerous than splenectomy. In the absence of dense

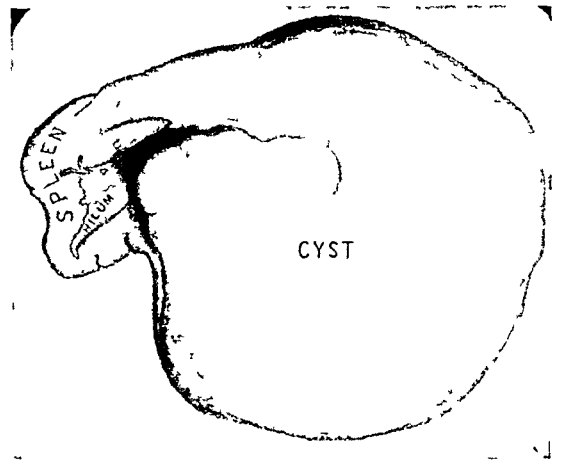


FIG. 3. Specimen after splenectomy.

adhesions the latter operation should offer no technical difficulties.

The following case of a patient referred by Dr. Joseph J. Berkowitz was admitted to the hospital December 5, 1928.

Female, twenty, occupation, bookkeeper. *Family history* negative. *Past history* negative except for the usual diseases of childhood. No history of malaria or traumatism.

*Present History.* Four years ago a swelling appeared in the upper part of the abdomen which grew gradually in size. For the past month she has had a feeling of pressure in the abdomen.

*Physical Examination.* Heart, lungs, and blood pressure normal. Examination of the abdomen shows the presence of a large mass in the epigastrium more marked on the left side, causing bulging of the left costal margin and extending downward to within 2 in. of the umbilicus. The mass is smooth and slightly tender. It moves with respiration and gives a sense of crepitation on palpation.

#### *Laboratory Findings.*

Urine negative

Hemoglobin 75 per cent

Red blood corpuscles 4,550,000

White blood corpuscles 8,720

Wassermann test negative.

*X-ray.* A gastrointestinal series revealed a normal stomach located in the right lower



quadrant with the duodenum in the normal position. The abnormal location of the stomach is apparently caused by pressure by the mass in the epigastrium.

The preoperative diagnosis was cyst of the spleen, probably echinococcus.

Operation revealed a large cyst attached to the spleen. The spleen itself was moderately enlarged. The cyst was thick walled and adherent to the diaphragm. Splenectomy was performed without special difficulties and the postoperative course was without incident.

*Laboratory Findings.* The cyst was intimately connected with the spleen and contained about 6 liters of thick chocolate colored fluid.

Microscopically the cyst contents consisted of degenerated blood and debris. There was no

endothelium in the inner lining of the cyst wall.

X-ray taken several weeks later showed the stomach in a normal position.

The patient continues to be well after three years and has suffered no disturbances from the loss of her spleen.

#### REFERENCES

1. BRYAN, W. A. Cysts of the spleen. *J. A. M. A.*, 45: 680, 1905.
2. FOWLER, R. H. Non-parasitic cysts of the spleen. *Surg. Gynec. Obst.*, 11: 133, 1910.
3. CALLOUST. Kystes hematogenes de la rate. Paris. Ollier-Hening, 1913. P. 118.
4. NOVAK, E. Large single cysts of spleen. *Surg., Gynec. Obst.*, 45: 586, 1927.
5. FRANK. *Ann. Surg.*, 85: 360, 1927.



#### REFERENCES OF DR. PEARSE\*

7. NASSETTI, F. Quoted from Halsted. Avvolgimento di vasi Sanguigni con lembi liberi di aponeurosi. *Atti della R. Acad. dei Fisiocritici in Siena*, April 26, 1912.
8. NEFF, J. M. A method for gradual automatic occlusion of the large blood vessels at one operation. *J. A. M. A.*, 57: 700, 1911.
9. PEARSE, H. E. A method for the gradual occlusion of the aorta. *Surg. Gynec. Obst.*, 46: 411, 1928.
10. REID, M. R. Partial occlusion of the aorta with

silk sutures and complete occlusion with fascial plugs; the effect of ligatures on the arterial wall. *J. Exper. Med.*, 40: 293, 1924.

11. SHEFFELAAR-KLOTS, T. The use of fascia lata for the occlusion of arteries in case of aneurysm. *Ann. Surg.*, 93: 635, 1931.

*Note after correcting proof:* Publications of James L. Campbell have been omitted. Six cases of partial occlusion of the common carotid are reported with clinical improvement. *Southern M. J.*, 19: 795, 1926; 21: 539, 1928.

\*Continued from p. 246.

# GENERAL PRINCIPLES IN THE DIAGNOSIS OF INJURIES OF THE LOWER BACK & PELVIS\*

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## INTRODUCTION

THE effect of trauma in the region of the lower back and pelvis seldom results in a solitary lesion of the muscular or bony framework. Injury to the protecting and supporting structures is frequently associated with damage to viscera contained in the bony pelvis, and neural apparatus in the spinal canal. These latter complications are of far-reaching effect, and generally overshadow in importance the primary lesion.

The effects of trauma cover a wide range; but it is precisely these contingencies which the orthopedic surgeon must be prepared to differentiate when he is confronted with a patient exhibiting pain in the lower back, walking, sitting, or standing disability, muscle spasm, and the local signs of injury in this region. A case may show but few or minor symptoms at first and appear to be of trivial import, and within a few hours progress to a serious cord lesion. On the other hand, the presence of severe shock, inability to void or incontinence, and obvious deformity, while significant, is not incompatible with complete recovery.

The scale of severity of back and pelvic injuries runs through the octaves of muscular strains, railway spines, subluxations, dislocations, fractures, gunshot and stab wounds, and the various combinations and complications of these.

## CORRELATION OF INJURIES

The erect posture of man, locomotion, and the majority of the purposeful motions of the lower extremities are dependent upon the integrity of the pelvic ring and

maintenance of the line of gravity in certain planes. Because of this interrelationship, impairment of a part affects the whole, and minor derangements are often productive of symptoms out of proportion to, or seemingly independent of the original trauma.

Consequently, a discussion of muscular strain of the back involves a consideration of fracture of the transverse processes of the lumbar vertebrae. Moorhead<sup>11</sup> states that dislocation of the dorsal and lumbar spine without fracture is rare; he quotes Keen to the effect that, "experimentally, dislocation, (without fracture), cannot be produced below the fifth dorsal spine." Frazier<sup>6</sup> estimates that of 100 injuries of the spinal column, 60 will be fracture-dislocations, 20, fractures, and 20, dislocations.

The lower dorsal and lumbar region is preeminently the location of fracture-dislocation. The potentiality of cord damage in the latter lesion is obvious; the cord may be contused, compressed, lacerated, or completely severed. Again, it is embarrassing at times to find that a fracture may unite with a good anatomical result, but through many related factors leave a static defect that is almost as disabling as the original injury.

Wilson and Cochrane<sup>14</sup> classify sacroiliac luxation as a variant of fracture of the posterior border of the ilium; and separation of the pubic symphysis as a variant of fracture of the pubic bones. In the latter case, if the bone is stronger than the ligaments, the articulation opens out. This cannot occur without injury or at least sprain of the sacroiliac joint.

Colp and Findlay<sup>3</sup> found in a small series of 35 cases, that 17 per cent of

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patients having fractures of the pelvis were unable to void afterwards, but only 8 + per cent had actual bladder injury.

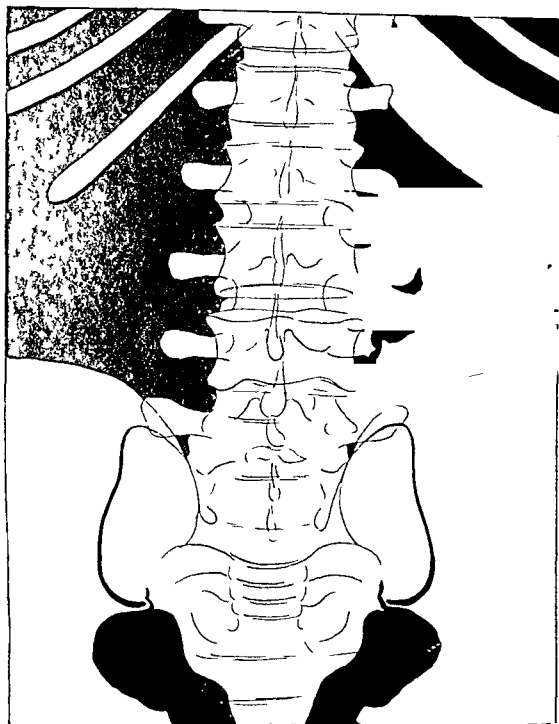


FIG. 1. Sketen from skiagraph showing fracture of transverse processes of fourth and fifth lumbar vertebrae, left.

S., Samuel, white farmer, aged thirty, received injury to back in fall from hay-loft. Did not result in any marked degree of disability and patient applied home remedies for a sprained back. Nature of injury was discovered several months later incident to routine examination for compensation as a World War veteran. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

They conclude that not all pelvic fractures involve injury of the genitourinary tract, but that 50 per cent of ruptured bladders occur with fractured pelvis. McWhorter<sup>10</sup> quoted Keyes to the effect that tears of the posterior urethra resulted only from a fracture, dislocation, or strain on the pelvis. Campbell's<sup>2</sup> figures approach these also: in 20 of 55 cases of ruptured bladder, there were associated pelvic fractures.

In 166 fractures of the pelvis in Bellevue Hospital from January 1919 to January 1928, 15 per cent, or 1 in 7, had vesical rupture. In 3 others, rupture of the posterior urethra

had occurred. Furthermore, in many cases of fracture without demonstrable vesical rupture, distressing urinary symptoms were present



FIG. 2. Print from skiagraph demonstrating fracture of right inferior articular process of fifth lumbar vertebra and right sacroiliac dislocation.

H., Paul, Sgt. Q.M.C., white soldier, aged thirty-one, thrown from truck, landing on his back heavily on frozen ground, and in addition to above, sustained fractures of ninth and tenth ribs, right. Soldier had extreme disability at first but returned to duty in six weeks and has had no recurrence of symptoms to date. Recent skiagraphs reveal no change in sacroiliac joints. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

as follows: acute retention 32, marked dysuria 5, and gross hematuria 36.

#### DEFINITION OF TERMS

The nosology of pelvic and low back injuries would be much clarified if there were less ambiguity displayed in their nomenclature. Fortunately, this region seems to have escaped the blight of eponyms; Kümmell's disease is unique, and even its legitimacy is doubtful.

Acceptance of the entity of sacroiliac, lumbosacral, and pubic symphysis sprains,

subluxations, dislocations, or separations implies that they are joints of the amphiarthroidal order at least. A priori, reference

injury of muscle tissue. This is all the more justified by the definition of sprain, which is explicit in its application; it is the



FIG. 3. Print from skiagraph illustrating doubtful fracture at posterior and inferior border of body of second lumbar vertebra, left side.

B., Earl, white soldier, aged twenty-three, admitted by transfer from another hospital nine months after back injury received by being thrown from horse at mounted drill. Original diagnosis was fracture of body of second lumbar vertebra at its anterior and left lateral lip. At that time sacralization of transverse process of fifth lumbar vertebra, right, was also diagnosed. Skiagraphs made nine months after injury do not confirm diagnosis of fracture, but do show a peculiar defect at posterior inferior border of body of second lumbar vertebra, left side. (*Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.*)

to these joints as synchondroses is inconsistent. Spondylolisthesis is a purely descriptive term, indecisive as to exact location, and should be discarded for lumbosacral subluxation or dislocation.

The use of the words strain and sprain interchangeably is not consonant with their etymological derivation. To strain, means to overuse; to overexercise. Kinetic energy is a property of muscle in contradistinction to the passivity of joint motion not initiated or controlled by muscle. Clearly, then, the term strain should be restricted to



FIG. 4. Reproduction from skiagraph showing sacralization of transverse process of fifth lumbar vertebra, right, with formation of false joint.

Same patient described in Figure 3; patient's back creaked on motion, and he complained of a variety of symptoms, majority of which were subjective. Sacralization is believed to account for fact that he left hospital only slightly improved. (*Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.*)

wrenching of a joint, with partial or complete injury of its attachments without luxation of bones.

Low back pain has been frequently ascribed to relaxation of the sacroiliac joints, whatever that may mean. Undoubtedly this terminology originated with the prevalent belief that during pregnancy there is a general relaxation of all the pelvic ligaments which allows to some extent at least, a definite increase in the diameters of the parturient canal. This ligamentous relaxation is a purely physiological process, and usage of the word to describe a traumatism is objectionable.

One writer speaks of diastasis of the vertebrae, apposite to a condition in which the vertebrae are separated from each

other in their vertical axes but without disturbance of the plane of the articular surfaces to each other. Without prejudice

most desirable. Sprain, subluxation, and dislocation, in order, are amply descriptive of the degrees of derangement.



FIG. 5. Sketch from skiagraph showing fracture of second lumbar vertebra which has healed with deformity but no symptoms.

P., William, white, ex-soldier, aged fifty-two received crushing injury of back in automobile wreck. There was jack-knife bending of back; no visceral symptoms, and patient returned to his occupation of day laborer in three months from date of injury. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

to this author's experience, I should say it does seem that this is just another superfluous name for a sprain of the vertebral joints involved.

There is some justification for the usage of the term separation as applicable to dislocation of the symphysis pubis. This joint enjoys very limited motion in a single plane, which results in a deviation of the pubic bones from one another in a horizontal direction.

Standardization of nomenclature of dislocations in the direction of simplicity is

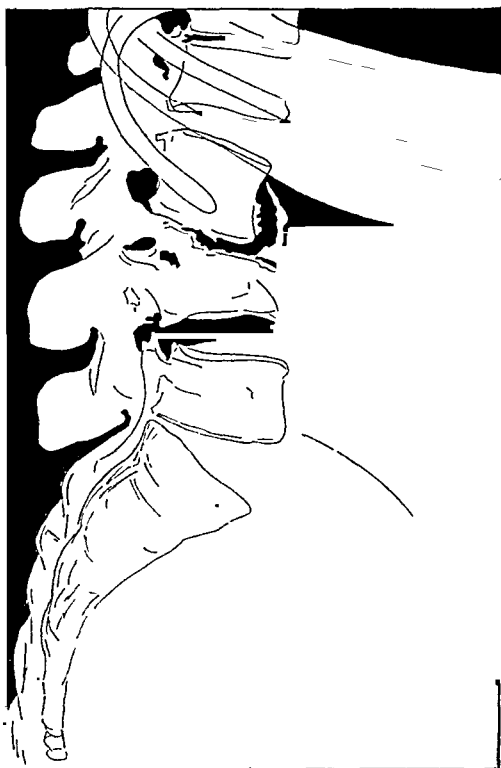


FIG. 6. Sketch from skiagraph illustrating compression, destruction, and almost complete absorption of body of third lumbar vertebra and partial absorption of fourth lumbar.

S., Oscar, colored ex-soldier, aged forty-three, admitted to this hospital for treatment of old osteomyelitis of greater trochanter of right femur, with chronic discharging sinus. Disease dated from injuries sustained twelve years previously, when engaged as a laborer, helping at housemoving. While placing supports under one corner of a house, it fell, compressing his lower back and right hip. Patient had transient visceral symptoms and long-continued disability following injury. Now able to walk without limp and do manual labor. Appearance is extremely suggestive of quiescent Pott's disease of spine rather than fracture. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

#### CLASSIFICATION OF INJURIES

Traumatism of the lower back and pelvis, without reference to surface wounds, permit of the following anatomical classification:

- |                               |   |  |
|-------------------------------|---|--|
| I. Muscle                     | { | 1. Contusion   |
|                               |   | 2. Strain  |
|                               |   | 3. Fibrositis  |
|                               |   | 4. Myositis ossificans   |
| II. Joint                     | { | 1. Sprain  |
|                               |   | 2. Subluxation   |
|                               |   | 3. Dislocation or separation   |
| III. Bone                     | { | a. Alteration of weight-bearing line from any cause<br>b. Spinal curvature |
|                               |   |  |
| IV. Gunshot and stab wounds   |   | 2. Fracture  |
| V. Associated visceral injury | { | 1. Spinal cord   |
|                               |   | 2. Genitourinary system  |
|                               |   | 3. Nerves and blood vessels  |
|                               |   | 4. Bowel   |

#### ANATOMICAL DISCUSSION

The more important muscles which may be involved in traumatism of the lower back include the latissimus dorsi, the erector spinae, the fifth layer of short muscles of the back, of which the inter-spinous and the intertransverse are examples, the quadratus lumborum, and the iliopsoas. The musculature of the back extends in almost unbroken continuity from the sacrum to the occiput. It has an enormous capacity for leverage on the trunk and lower extremity. Also the gap between the ribs and the pelvis is bridged by muscle alone. These circumstances are ample explanation of the frequency of muscular strains and of avulsion fractures, when muscle function is perverted.

Best<sup>1</sup> thinks that the most frequent and major cause of low back pain is a traumatic myositis of the sacrospinalis and gluteal muscles. The possibility of a muscular fibrositis and even of myositis ossificans, in this connection, cannot be denied.

The spine supports the cranium, and is the connecting link between it and the pelvis. It provides a durable and stable but flexible container for the spinal cord, insuring neural continuity from the cerebrum and higher centers to the periphery. The following verbatim quotation from Gray's<sup>7</sup> "Anatomy" is classic.

The construction of the spinal column, of a number of pieces, securely connected together and enjoying only a slight range of

movement between any two individual pieces, though permitting of a very considerable range of movement, as a whole, allows a



FIG. 7. Print from skiagraph showing multiple fractures of right pelvis with subluxation of right sacroiliac joint. W., James, white soldier, aged twenty-six, received multiple injuries in motorcycle crash, more important of which were fractures of right os pubis and ischium and rupture of urinary bladder. Extra-peritoneal rupture of bladder was revealed by exploratory operation; there was about 800 c.c. of urine in space of Retzius; there was a severe Y-shaped tear of right lateral wall of bladder; longest limb of tear extended from near vault on right, downward and forward, 12 cm., to base. Short limbs of Y were about 5 cm. long. Wound in bladder was repaired, and drainage instituted suprapubically and also by indwelling urethral catheter. Soldier returned to duty in ninety days.

(1) Fracture line in horizontal ramus of os pubis. (2) Fracture in body of os pubis, internal to pubic spine. (3) Fracture in ascending ramus of ischium. (4) Subluxation of right sacroiliac joint. (Surg. Serv., Tripler U. S. Army Gen. Hosp., Honolulu, T. H.)

sufficient degree of mobility without any material diminution of strength. The main joints of which the spine is composed, together with the very varied movements to which it is subjected, render it liable to sprains, which may complicate other injuries or may exist alone; but so closely are the individual vertebrae articulated that these sprains are

seldom severe, and an amount of violence sufficiently great to produce tearing of the ligaments would tend to cause a dislocation

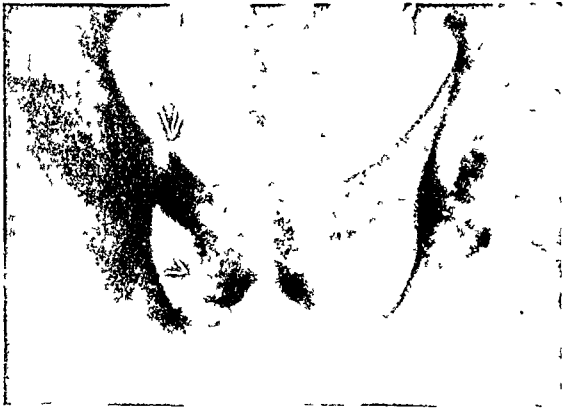


FIG. 8. Print from skiagraph showing fracture of both rami of right pubis. T., Everett R., white soldier, aged twenty-five, incurred above injury in automobile wreck; was thrown clear from car striking right side of pelvis against tree. No complications and soldier returned to duty in forty-five days. (Surg. Serv., Tripler U. S. Army Gen. Hosp., Honolulu, T. H.)

or fracture. The further safety of the column and its less liability to injury is provided for by its disposition in curves instead of in one straight line. For it is an elastic column, and must first bend before it breaks; under these circumstances, being made up of three curves, it represents three columns, and greater force is required to produce bending of a short column than of a longer one that is equal to it in breadth and material. Again the safety of the column is provided for by the interposition of the intervertebral disks between the bodies of the vertebrae, which act as admirable buffers in counteracting the effects of violent jars or shocks. Fracture-dislocation of the vertebral column may be caused by direct or indirect violence, or by a combination of the two, as when a person falling from a height strikes against some prominence and is doubled over it. The fractures from indirect violence are the more common, and here the bodies of the vertebrae are compressed, while the arches are torn asunder; while in fractures from direct violence, the arches are compressed



FIG. 9. Print from skiagraph showing multiple fractures of pelvis with much deformity. B., James L., a white ex-soldier, aged thirty-five, incurred multiple fractures of pelvis and rupture of bladder in an automobile wreck; there were double fractures of horizontal rami of pubis and ascending rami of ischium. Disability was immediate and complete. Displacement of fragments was more than usual. Bladder was repaired successfully and patient made a slow and stormy recovery. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)



FIG. 10. Print from skiagraph of same case shown in Figure 9, taken four months after injury. Union has occurred, but is probably fibrous. Patient was discharged after ten months hospitalization, able to walk and do light work. At time of discharge his greatest complaint was inability to find a comfortable sitting position and inability to rise or sit down smoothly and quickly. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

and the bodies of the vertebrae separated from each other. It will therefore be seen that in both classes of injury the spinal cord is the

lumbosacral and sacroiliac joints, as well as the symphysis pubis, lies not in the motion they furnish, but in the expansion



FIG. 11. Sketch from skiagraph showing lumbosacral dislocation (spondylolisthesis). R., Waldo A., white ex-officer U. S. Army, aged forty-six, sustained multiple injuries and wounds in action during the World War, including aeroplane crash. Symptoms of irritation of peripheral branches of lumbar plexus prominent on admission, and ascribed by patient to fall on back incurred in 1919. Patient left hospital but slightly improved by physiotherapy and other accepted methods of treatment. Did not take advantage of operative fusion of lumbosacral joint. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

part least likely to be injured, and may escape damage even when there has been a considerable lesion of the bony framework.

The pelvis is built to *stand under*, to *sit on*, to *hang to*, and to *cover in*. It must have strength and elasticity to bear constant loads under varying conditions. It absorbs shocks from above and below. The individual units of the pelvis, the ossa innominata and sacrum which includes the coccyx, are tied together by joints which have a very small range of motion but an extensive capacity for distributing stresses and strains. The value of the

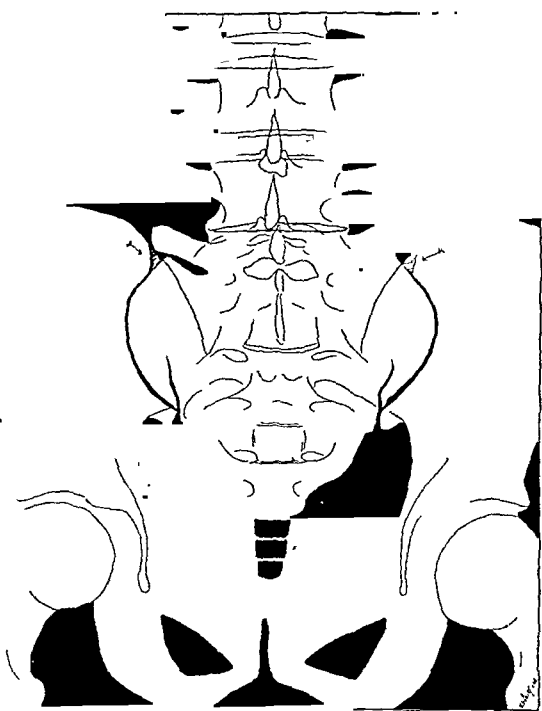


FIG. 12. Sketch from skiagraph of anteroposterior view of same patient shown in Figure 11, illustrating rotation of sacrum in lumbosacral dislocation. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

and contraction of the pelvic ring as a unit which their structure and strategic location permits.

With but little stretch of the imagination one can visualize the pelvis as composed of a series of four trusses, one anterior and one posterior on each side. These trusses close in the pelvis with angles apposed at the acetabula, the anterior trusses being situated in a lower plane than the posterior.

The two posterior trusses, represented by the ilia, are tied together at their bases by the mortised-in sacrum as a tie-beam; the apices fuse laterally with the superior angle and part of the base of the anterior trusses to form the acetabula, which serves as a tie-rod to insure resistance to upward and lateral compression. A portion of the base of the anterior trusses forms the



ischial and pubic segments of the acetabulum; a little more than two-fifths by the ischium and one-fifth by the pubis. The

#### ELEMENTS OF DIAGNOSIS

The first prerequisite in diagnosis is to establish the fact of a recent trauma which



FIG. 13 Print from skiagraph, lateral view of same patient shown in Figures 11 and 12; giving more detail of lumbosacral dislocation. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

inferior angle of the base of these trusses and the remainder of the base form the ischial tuberosity, and carry the sitting weight of the body. The flattened apices come together anteriorly to form the symphysis pubis.

The pelvis is admirably suited to withstand downward, upward, and lateral compression, and is least able to endure force applied in the sagittal direction. Wilson and Cochrane<sup>14</sup> enumerate five weak points; the two sacroiliac joints or the area just external to the joints, the symphysis pubis, and a point midway between the symphysis and the acetabulum on each side. Fractures of the pelvis are most common at these points.



FIG. 14. Print from skiagraph anteroposterior view of same patient shown in Figures 11, 12, and 13. Rotation of sacrum is well shown. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

is adequate in degree and in proper relation to the symptoms present.

The importance of a careful, complete, and pertinent history cannot be overestimated. A history may seem superfluous in the presence of self-evident injury, but the existence of symptoms previous to the injury frequently has great bearing on the subsequent development of the case. The chronological appearance of the symptoms, their progression, and the appearance of contemporary signs is of the utmost value, particularly in the definition of spinal cord involvement and its extent.

It is amazing how many things may be responsible for backache and more or less disability but which are totally unrelated to trauma. It is not unusual for the symptoms to be described as having commenced about the time of an injury which is generally too trivial to have been effective. This is not to say that these are all instances

of neurasthenia, hysteria, or hystero-neurosis. Low back pain is commonly met with in visceroptosis, floating kidney, arthritis, neuritis, intercostal neuralgia, lumbago, sciatica, spinal cord lesions, chronic uterine, pelvic, and abdominal disease, static defects, spinal asymmetry, atypical vertebrae, and other developmental defects.

From such a welter of varied and vague paternity, the protagonists of sacroiliac relaxation, have resurrected it, as a common cause of low back pain.

#### PHYSICAL INVENTORY

A meticulous physical examination will usually reveal signs indicative of injury to a particular structure; rectal and vaginal examination should not be overlooked as they will permit palpation of nearly all the pelvic bones including the inner surface of the acetabulum. Tenderness on pressure, swelling, ecchymosis or discoloration, muscle spasm, restriction of motion, and pain on active or passive motion, are present in greater or less degree according to the severity of the injury. If deformity and preternatural mobility are present, together with these symptoms, fracture is almost certain, though fracture-dislocation is overwhelmingly the most common variety of fracture in the lower spine. Crepitus is rarely elicited in fractures of the spine and pelvis.

Prompt recognition of complicating visceral injury is the paramount consideration of diagnosis. Paraplegia, or lesser degrees of motor failure, sensory loss, disturbed reflexes, and interference with bladder and rectal function are evidence of cord involvement; inability to void, difficult and bloody urination, and bleeding from the urethra are suggestive of bladder damage. Perineal extravasation is a late development, but is pathognomonic of ruptured bladder. Hematomata and signs of circulatory weakness point to laceration of an important blood vessel. In addition to these, the symptoms of shock are present in greater or less degree determined by the gravity of the complication.

#### RADIOGRAPHY

The roentgen-ray is the final arbiter of the diagnosis in many cases of fractures



FIG. 15. Print from skiagraph showing dislocation of left sacroiliac joint. O., Maryan, white soldier, aged thirty-two, was received at this hospital by transfer from another hospital for treatment of severe left-sided sciatica. Symptoms dated from severe back strain incurred five months previously while cranking heavy truck. Soldier returned to duty nine months after original injury, however, without complete relief of symptoms. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

and dislocations of the lower spine and pelvis. The development of the x-ray has been productive of great advance in diagnostic methods in this field particularly. It has demonstrated the occurrence of many lesions formerly unsuspected, specifically, fractured lumbar transverse processes. This lesion was not recognized prior to 1908. Conversely, the x-ray has great negative value, and has served to exclude certain purely functional conditions, such as concussion of the spinal cord, the euphemistic "railway spine."

It must not be forgotten also, that the x-ray has positive value in this field only in relation to the bony structures. Proper

regard must be had for the limitations of skiagraphs in the way of distortion. Pictures should be made in at least three

latter comes only with experience; Pancoast<sup>12</sup> sounds a warning in the following words:

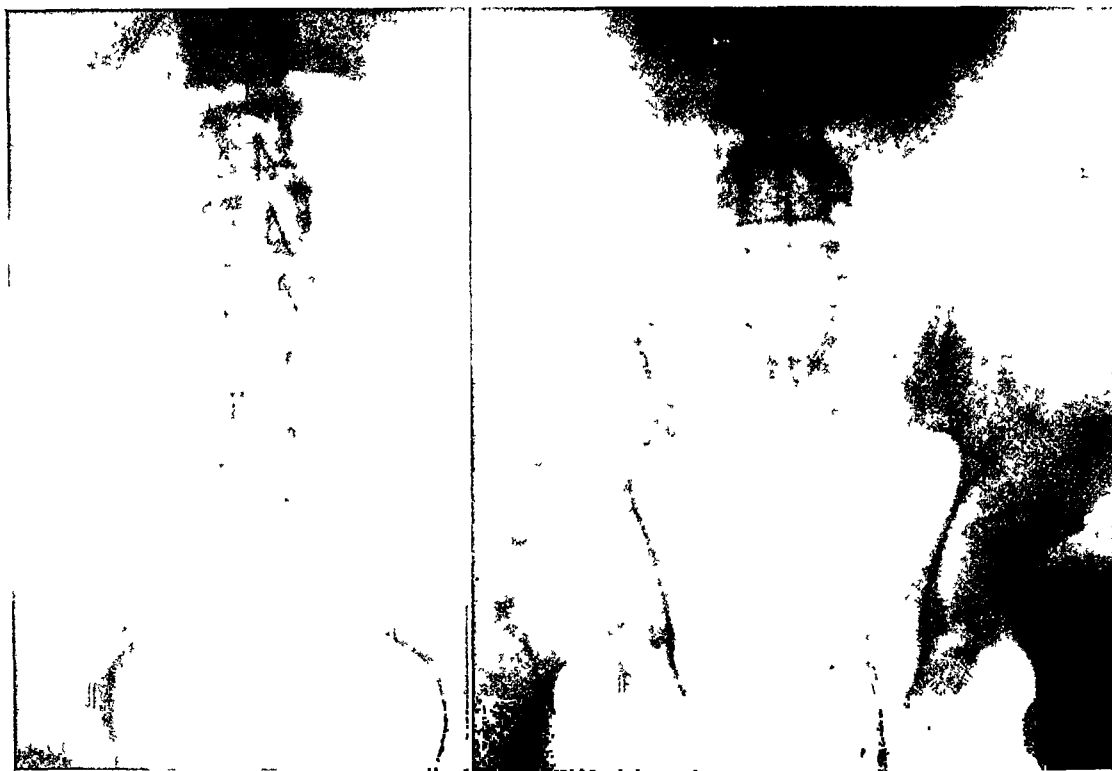


FIG. 16. Print from skiagraph of same patient shown in Figure 15. Static defect of scoliosis, left, of lumbar spine, secondary to primary injury. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

FIG. 17. Print from skiagraph interpreted as being essentially normal. E., Edward, white ex-soldier, aged thirty-eight, complained of great pain and disability referred to region of both sacroiliac joints; symptoms were said to have been of eleven years' duration without progression. In all other respects, physical examination of patient was negative for demonstrable pathology. Diagnoses had been made in other hospitals of arthritis of spine, sciatica, and relaxation of sacroiliac joints. Latter seemed to be most acceptable to patient: he was discharged as improved. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

planes to obtain complete information: the anteroposterior, lateral, and oblique. Views of delimited areas give the sharpest detail. Consequently stereographic films are essential in most instances. The gross anatomical structure of the spine and pelvis is complex; shadows of the various portions occupy different planes, yet they are depicted upon the single plane of a skiagraph. To differentiate the shadows of the various components, they must be viewed stereographically.

Accuracy in diagnosis not only implies correct technique but requires great discretion in interpreting the findings. The

Extreme caution must be exercised in interpreting the appearance of joint spaces for narrowing or widening as indicative of trauma or inflammation, as the spaces vary greatly in different individuals and in different joints in the same individual. Also the effect of variations in the angles of the joints may be very misleading. [With particular reference to the sacroiliac joints the same observer states]: It is useless to try and interpret slight

displacements of the sacroiliac joints without stereoscopic films. The width of the space depends on the thickness of the articular

in. Best<sup>1</sup> believes that little emphasis should be placed on spinal anomalies and abnormal outlines observed radiographi-



FIG. 18. Print from skiagraph showing anomaly of six lumbar vertebrae. Z, James, white ex-soldier, age not known; symptoms complained of were rheumatism of back. Patient was skiagraphed during course of examination for claim for compensation as a World War veteran. He was not hospitalized. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)



FIG. 19. Print from skiagraph showing a peculiar teat like process at lower angle of left sacroiliac joint, and also a patent sacral canal as high as third sacral segment. P., William, white ex-soldier, aged forty-four, under treatment for cerebrospinal syphilis. These anomalies were without significance in so far as symptoms were concerned. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

cartilages, which decreases with age. Relaxation can't be determined unless there be some displacement.

#### STRUCTURAL ABNORMALITIES

The connection of structural abnormalities or inequalities with low back pain is not clear, though the weight attached to their presence is being more and more discounted. Jones and Lovett<sup>9</sup> state that in 70 skeletons measured by Garson, the lower limbs were the same length in only 10. Morton measured 513 normal boys, and found that 292 presented an inequality in the lower limbs varying from  $\frac{1}{8}$  to  $\frac{1}{5}$

cally. He mentions Osgood's finding that 50 per cent of the plates taken at the Massachusetts General Hospital for various troubles did not show normal outlines of the back region.

It is a common observation that extra vertebrae, sacralized lumbar vertebrae, and even spina bifida, are frequently discovered in patients who are without symptoms and unaware of the existence of any abnormality.

The relation of low back pain to injury of the sacroiliac and lumbosacral joints has been productive of the most acrimonious discussion and contention. Sacroiliac

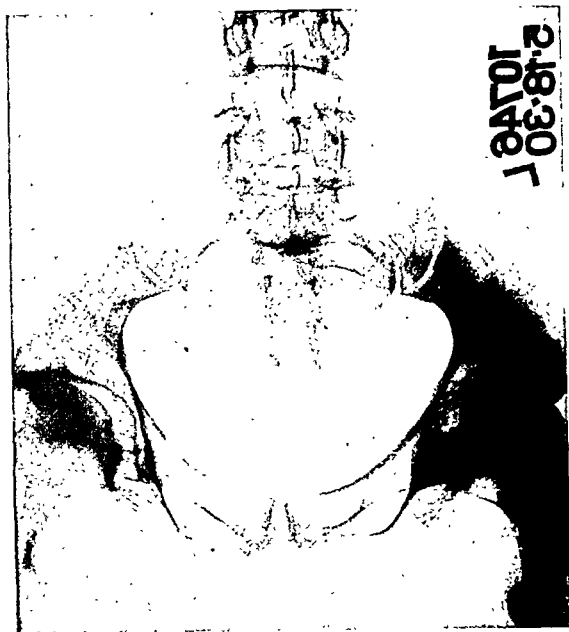


FIG. 20.

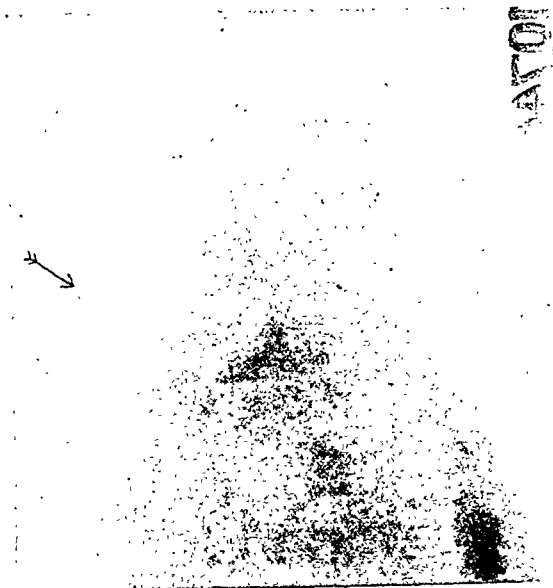


FIG. 21.

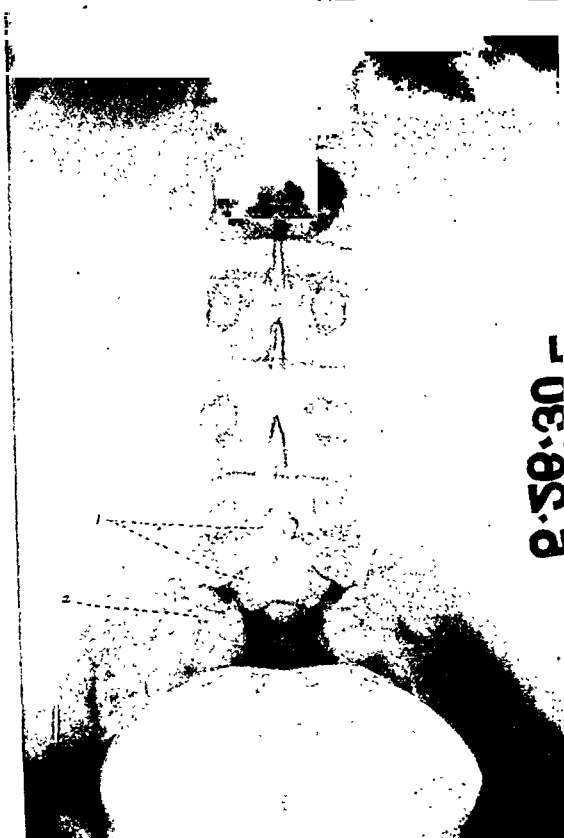


FIG. 22.



FIG. 23.

For legends see page 265.

dislocation has a literature all its own, since Goldthwaite first reported 500 cases in 1905. Diverse opinions are expressed

All textbook authorities describe different degrees of sacroiliac derangement resulting from trauma, but few mention lumbosacral

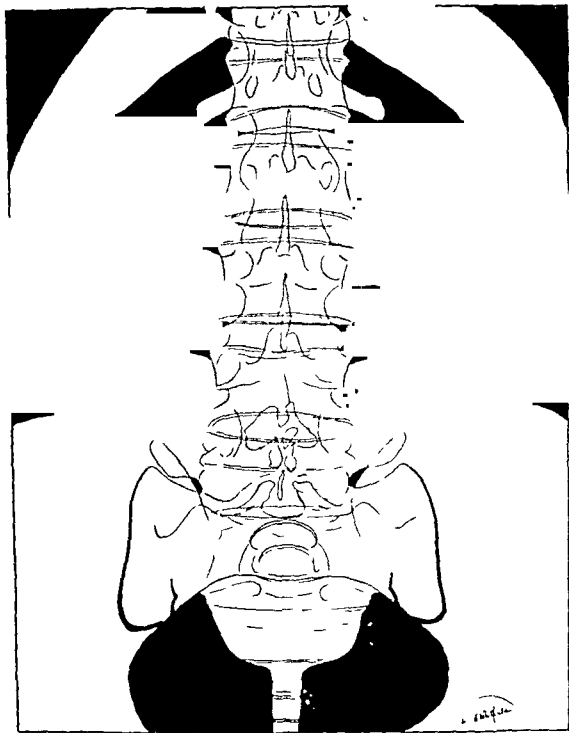


FIG. 24. Sketch from skiagraph; anteroposterior view of same patient shown in Figures 22 and 23, accentuating defects mentioned above. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

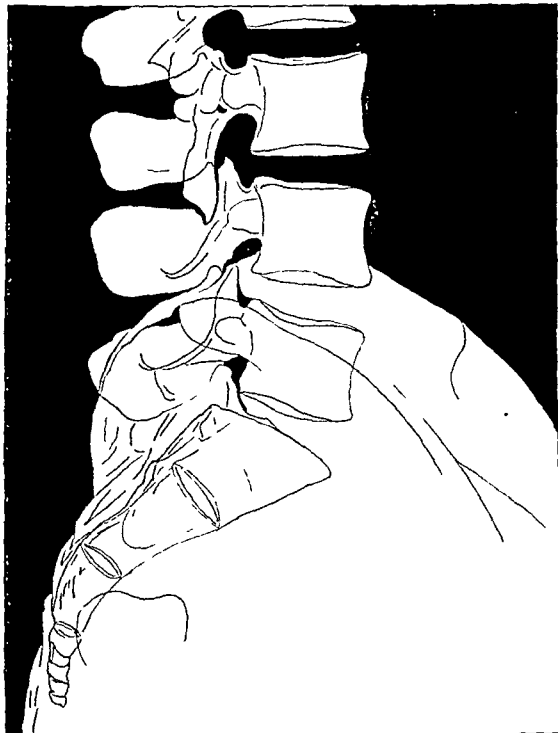


FIG. 25. Sketch from skiagraph; lateral view of same patient shown in Figures 22, 23, and 24, accentuating defects mentioned above. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

by men of undoubted experience. One of the writers of Jones and Lovett's "Orthopedic Surgery" is quoted as never having seen a case of sacroiliac relaxation, subluxation, or separation. Forrester<sup>5</sup> doubts the existence of sacroiliac strain, and says Sir Robert Jones agrees with him.

dislocation. Whitman,<sup>13</sup> perhaps, gives the most clear description of this condition, and uses the term spondylolisthesis. He states, however, that the lesion may originate independently of trauma from debilitated states and disease.

FIG. 20. Print from skiagraph showing female type of pelvis; shallow, broad and rounded, with wide pubic arch. Bones are delicate. H., Ambrose C., a white ex-soldier, aged thirty-eight, admitted for repair of femoral hernia. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park., Ark.)

FIG. 21. Print from skiagraph: lateral view of same patient shown in Figure 20, illustrating anomalous angle of sacrum with lumbar spine conforming to female type of pelvis. No symptoms referent to spine. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

FIG. 22. Print from skiagraph showing a mild arthritis of spine but of greater interest, a number of anomalies: (1) Lack of union of posterior vertebral arches of fifth lumbar and first sacral segments. (2) Lack of fusion of lateral masses of first and sacral segments. H., Thomas, C., a white soldier, aged twenty-two, admitted by transfer from another hospital for treatment of sequelae of acute rheumatic fever involving all joints of both extremities: valvular heart disease was a complication. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

FIG. 23. Print from skiagraph showing detail of sacrum and coccyx of same patient shown in Figure 22. There are only four segments in sacrum, and none of segments are united by bone; there is evidently a nutritional disturbance. (Surg. Serv., Army & Navy Gen. Hosp., Hot Springs Nat. Park, Ark.)

Hibbs<sup>8</sup> follows Von Lackum and believes that the important factor in lumbosacral strain is the increase in the angle of inclination of the superior surface of the sacrum to the horizontal, which should not exceed  $42.5^\circ$ ; the normal is  $25^\circ$ . He states that by means of skiagraphs taken anteroposteriorly from below, at an angle of  $45^\circ$ , both the lumbosacral and sacroiliac joints can be clearly delineated. This served as the basis for his spine fusion operation in a series of 147 with pain and disability due to developmental defects at the lumbosacral joint. In this series of cases he secured a large percentage of cures.

There can be no disagreement as to sacroiliac dislocation, when in addition to the history of trauma and with subjective symptoms, there is elevation or depression of the posterior superior iliac spine, or displacement laterally. But this is exactly the rock on which the whole discussion splits, for the occurrence of such cases is most rare, and always in association with severe fractures. The x-ray appearance cannot be used as corroborative evidence to support a diagnosis of lesser degrees of dislocation, which have been variously termed sacroiliac strains, subluxations, re-

laxations, etc. There is a paucity of definite findings in these latter cases.

Cox,<sup>4</sup> in writing of sacroiliac subluxation admits as much, when he says: "As strange as it may seem, the x-ray offers little help in the diagnosis, positive findings being secured in only 7 out of 300 of Paul Magnuson's series, and in only 3 cases of my series."

One cannot adopt too much of an ex cathedra attitude in this situation. However, the fact remains, that in the majority of these cases, the diagnosis rests on a purely clinical basis. This is a disquieting thought, for treatment predicated on clinical grounds only will continue to be empirical and more or less uncertain in result.

#### SUMMARY

1. Injury of the lower back has great potentiality for disability.
2. It is most important to correlate the history, symptoms, and laboratory findings, in arriving at a diagnosis.
3. It must be realized that the disability ascribed to sacroiliac and lumbosacral derangement of any, except extreme degree, has very little beyond subjective symptoms to support the diagnosis.

#### REFERENCES

1. BEST, R. R. A contribution to the study of low back pain. *Surg. Gynec. Obst.*, 45: 485-492, 1927.
2. CAMPBELL, M. F. Rupture of the bladder, a clinical study of fifty-five cases. *Surg. Gynec. Obst.*, 49: 540-546, 1929.
3. COLP, R., and FINDLAY, R. T. Fractures of the pelvis. *Surg. Gynec. Obst.*, 49: 847-853, 1929.
4. COX, H. H. Sacro-iliac subluxation as a cause of backache. *Surg. Gynec. Obst.*, 45: 637-649, 1927.
5. FORRESTER, C. R. G. Imperative Traumatic Surgery. Ed. 1, New York, Paul B. Hoeber Inc., 1929, pp. 216-218.
6. FRAZIER, C. H. Surgery of the spine and spinal Cord. Ed. 1, New York, Appleton, 1918, pp. 325-497.
7. GRAY, H. Anatomy. Ed. 18, Phila., Lea and Febiger, 1910, pp. 68-69.
8. HIBBS, R. A., and SWIFT, W. E. Developmental abnormalities at the lumbosacral juncture causing pain and disability. A report of one hundred and forty-seven patients treated by the spine fusion operation. *Surg. Gynec. Obst.*, 48: 604-612, 1929.
9. JONES, SIR R., and LOVETT, R. W. Orthopedic Surgery. Ed. 1, New York, Wood, 1923, pp. 311-345.
10. McWHORTER, G. L. Osteomyelitis of the ischium and pubis. *Surg. Gynec. Obst.*, 49: 205-212, 1929.
11. MOORHEAD, J. J. Traumatic Surgery. Ed. 2, Phila., Saunders, 1921, pp. 575-622.
12. PANCOAST, H. K. The Roentgen Examination of the Spine. Chapter IV, Frazier's Surgery of the Spine and Spinal Cord. Ed. 1, New York, Appleton, 1918, pp. 223-264.
13. WHITMAN, R. Orthopaedic Surgery. Ed. 8, Phila., Lea and Febiger, 1927, pp. 129-132.
14. WILSON, P. D., and COCHRANE, W. A. Fractures and Dislocations. Ed. 1, Phila., J. B. Lippincott Co., 1925, pp. 426-446.

# IMPLANTATION OF FASCIA IN THE ROUND LIGAMENTS FOR RETRODISPLACEMENTS OF THE UTERUS\*

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A REVIEW of the literature discloses that over one hundred surgical procedures have been described for the correction of retrodisplacements of the uterus. The majority of these operations have already been justly discarded; the few which have survived all employ the principle that a change in the insertion of the distal portions of the round ligaments shortens their pull and will bring the uterus, according to the type of operation performed, more or less upward and forward. When, fortunately, only the distal halves of the round ligaments are weakened and stretched the permanent results are fairly satisfactory; provided that a relaxed vaginal floor or other pelvic pathology if present, is corrected. The same procedure will not be followed by a permanent cure if applied to round ligaments whose entire lengths have become lax and weak, either as the result of a congenital insufficiency inherent in the tissues themselves, or as a result of failure to undergo a complete involution after the puerperium. It is for the purpose of strengthening two of the main supports of the uterus, and by so doing prevent recurrences, that we are transplanting fascia in the round ligaments, and advocate this procedure in the above type of case as a decided improvement over the standard operations.

## TECHNIQUE OF OPERATION

The patient is placed in an extreme Trendelenburg position. An incision is made below the umbilicus a little to the right of the midline, and exposes the sheath of the right rectus muscle for about 5 inches; the sheath is incised the whole length of the skin incision, the peritoneum

cut and the pelvis and abdomen explored.

*Step 1.* The uterine and distal abdominal ends of the right round ligament are grasped with Allis clamps. With a scalpel the peritoneum overlying the top of the round ligament between the two Allis clamps is incised. This incision must not extend into the uterine wall if the patient is of child-bearing age; if the patient is sterile or is made sterile, then the incision over the ligament is carried into the musculature of the uterus. By scalpel dissection, the incised peritoneal covering of the round ligament is deflected to the right and to the left, exposing the muscular fibers of the round ligament. It is imperative at this stage to secure absolute hemostasis in order to avoid a subsequent hematoma.

*Step 2.* A strip of fascia about  $\frac{1}{4}$  inch in width, free of fat and slightly longer than the dissected round ligament, is excised together with its underlying muscular fibers, from the right leaf of the incised rectus sheath.

*Step 3.* The fascial strip is now transplanted, care being taken to have its muscular side in apposition with the exposed muscular fibers of the dissected round ligament. In a child-bearing patient, there must be a  $\frac{1}{4}$  inch space between the inner end of the fascial strip and the uterus, in order to avoid an attachment of the transplanted fascia to the uterine wall, and so cause dystocia in future pregnancies. If the patient has been sterilized, then the inner end of the fascial strip is sutured firmly in the body of the uterus. If not, a fine, plain catgut suture is passed through the uterine end of the round ligament and the transplant. The right

\* Submitted for publication July 20, 1931.



and left deflected leaves of the peritoneal covering of the round ligament are next sewed over the fascial strip by a continuous

staple. In this stab wound an artery forceps is introduced through the rectus muscle and peritoneum,



FIG. 1. Uterine and distal abdominal ends of round ligament are grasped with Allis clamps. With scalpel peritoneum overlying top of round ligament between two Allis clamps is incised. This incision must not extend into uterine wall if patient is of child-bearing age; if patient is sterile or is made sterile, then incision over ligament is carried into musculature of uterus.

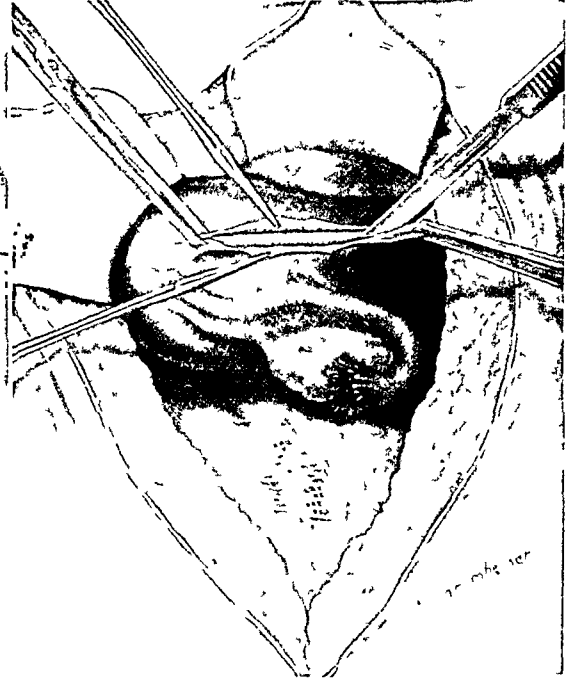


FIG. 2. By scalpel dissection, incised peritoneal covering of round ligament is deflected to right and left, exposing muscle fibers of round ligament.

plain catgut suture, leaving the outer end of the transplant protruding slightly from the round ligament.

*Step 4.* The same procedure is performed on the left side.

*Step 5.* Any pelvic or abdominal pathology present, is now attended to.

*Step 6.* The operation now follows closely the Gilliam technique for a suspension. On each side the round ligament is grasped by an Allis clamp at the point where the outer end of the transplanted fascial strip protrudes; a temporary ligature is placed around it and the ends of the ligature are caught in a forceps. About 1 inch from the margin of the abdominal incision and  $1\frac{1}{2}$  inches above the pubic bone a stab incision is made in the aponeu-

sis of each rectus muscle. In this stab wound an artery forceps is introduced through the rectus muscle and peritoneum, and the ligature about the round ligament grasped and brought out, bringing both ligament and end of the fascial transplant with it. The loop of each ligament with its transplanted fascial strip is drawn through until the fundus uteri rests well forward. The loop of each side, together with its transplant, is then sutured securely to the aponeurosis of the rectus muscle.

#### INDICATIONS AND CONTRAINDICATIONS

The operation is indicated in the following types of cases:

1. Retroversion and retroflexion causing symptoms, and where the displacement is due primarily to a congenital lack of tone and muscular development affecting the entire lengths of the round ligaments. Such patients as a rule present other evidence of deficient tissue supporting

strength, such as enteroptosis, diastasis of the abdominal recti, etc.

2. Retroversion produced by repeated

strips in the body of the uterus is employed. The patient must of course be either in her menopause or artificially sterilized.



FIG. 3. A. Strip of fascia is excised from right leaf of incised rectus sheath. B. Fascial strip is transplanted with its muscular side in apposition with exposed muscle fibers of round ligament. In child-bearing patient there must be  $\frac{1}{4}$  in. space between proximal end of fascial strip and uterus. Fine plain catgut suture is passed through uterine end of round ligament and transplant. C. In sterile patient incision over round ligament is carried into body of uterus, and inner end of fascial strip is sutured firmly into it.

pregnancies. In these uteri most of the musculature has been replaced by fibrous tissue, so that the organ is large and hard and has lost its elasticity. This type of case shows a large percentage of partial or complete recurrences following the commonly used suspension operations.

3. Prolapse of every degree; if a procidentia exists and the patient is a poor risk for a more radical procedure, the technique of suturing securely the fascial



FIG. 4. Right and left deflected leaves of peritoneal covering of round ligament are sewed over fascial strip by continuous plain catgut suture, leaving outer end of transplant protruding from round ligament.

The operation is contraindicated in the presence of either a pelvic or abdominal infection.

#### SUMMARY

The textbook operations for retrodisplacements of the uterus are followed by a fair percentage of recurrences. This is due to the fact that such operations do not actually strengthen the supporting structures of the uterus which have become weakened, either through acquired or constitutional defects. A method is offered by which the round ligaments are strengthened by transplanting into them fascial strips, so that they can supply the support of missing factors as well as their own quota. In case of pregnancy the round ligaments are still free to undergo hyperplasia and hypertrophy and retain their elasticity. This operation is indicated only when the entire lengths of the round ligaments are weakened and lax; it is contraindicated in the presence of an abdominal or pelvic infection.

# NEUROSURGERY IN DISEASES OF THE URINARY BLADDER\*

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THE nerves which reach the urinary bladder belong to three systems: (1) the sympathetic division of the

these contributions are termed its lateral roots. A middle root reaches their angle of convergence, from the preaortic nervous

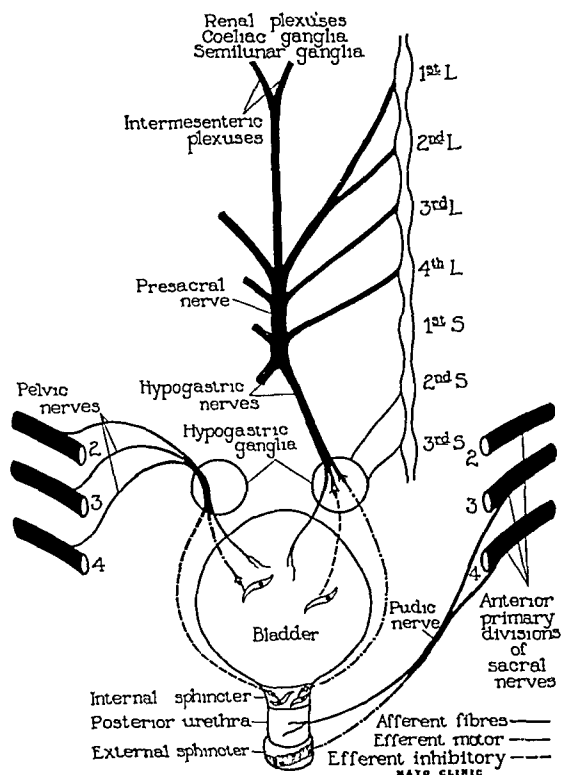


FIG. 1. Diagram of nerve supply to bladder.

autonomic system, (2) the parasympathetic division of the autonomic system, and (3) the somatic system (Fig. 1).

## ANATOMY

**Sympathetic Nerves.** Sympathetic fibers for the pelvic viscera, including the bladder, are finally concentrated in a strand termed the presacral nerve. This nerve receives, on each side, a considerable contribution from the first and second lumbar paravertebral sympathetic ganglia;

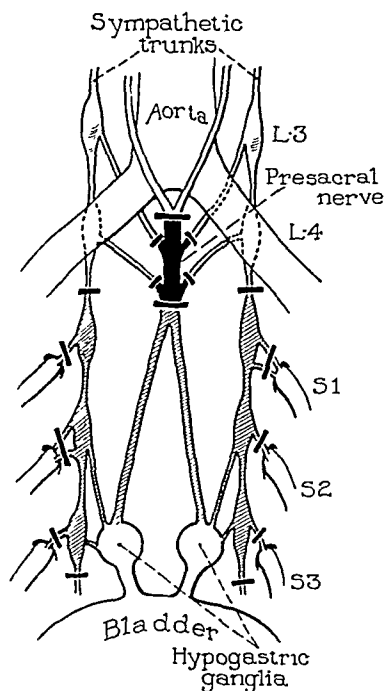


FIG. 2. Pieri's operation for vesical pain. Solid and hatched nerves are interrupted.

plexus, and as such it enters into communication with the coeliac, semilunar, and aorticorenal ganglia. Smaller branches connect the presacral nerve to the third and fourth lumbar ganglia on each side. At the level of the promontory of the sacrum it divides into the two hypogastric nerves, which join the posterosuperior angles of the corresponding hypogastric ganglia. The nerve lies in the median line, or a little to the left of it, immediately under the posterior parietal peritoneum. After opening the peritoneum over the nerve,

\* Read before the New York Academy of Medicine, December 16, 1931.

all its component parts can be resected by removing the tissue between the left common iliac vein and the right common iliac artery.

*Parasympathetic Nerves.* Parasympathetic fibers are detached from the anterior primary divisions of the second, third and fourth sacral nerves. They reach the posterior borders of the hypogastric ganglia.

*Hypogastric Ganglia.* These ganglia form a firm network of nerve tissue; each ganglion lies on a lateral aspect of the rectum. The cells are those of the second relay of the sympathetic path to the viscus; passing through the ganglia, without any such interruption of their courses, are the efferent fibers of the parasympathetic system, and afferent fibers belonging to both sympathetic and parasympathetic systems.

*Vesical Nerves.* The ultimate nerves to the bladder leave the anterior borders of the hypogastric ganglia, and spread out over the walls of the viscus. From these branches filaments pass to the ureters, the vasa deferentia, the seminal vesicles, and the prostate gland.

*Somatic Nerves.* Somatic fibers derived from the anterior primary divisions of the third and fourth sacral nerves pass in the pudic nerves to innervate the external sphincter of the bladder; possibly the pudic nerves also contain some afferent sensory fibers from the posterior urethra.

#### PHYSIOLOGY

The functions ascribed to the various nerves in the following section have been determined in the human being. This point is significant, because the innervation of the bladder differs from species to species, and there may be differences between the sexes of the same species.

*Sympathetic Nerves.* (1) Closure of the ureterovesical orifices. (2) Contraction of the trigone; both these effects of stimulation of the presacral nerve have been observed with the cystoscope. (3) Closure of the internal sphincter. This has been

observed from the posterior urethra, with a Braasch cystoscope, following stimulation of the presacral nerve. Closure can be deduced from the force with which an instrument introduced into the bladder is grasped, following such stimulation. (4) Contraction of the musculature of the prostate gland, seminal vesicles, and ejaculatory ducts. On stimulation of the presacral nerve, the expulsion of seminal fluid into the prostatic urethra can be seen with the cysto-urethroscope. (5) Conveyance of sensations of pain from the bladder. This function has been ascertained by noting the effect of mechanical or electrical stimulation of the presacral nerve, while the patient was under the influence of a low spinal anesthetic. (6) Inhibition of the expulsive mechanism of the bladder. This has been deduced from the immediate active dilatation of the bladder which followed the intravenous administration of epinephrine (a hormonal stimulant for sympathetic nerves).

*Parasympathetic Nerves.* (1) Initiation and augmentation of the contractions of the musculature of the bladder. Paresis or paralysis of the bladder is known to follow lesions in any part of the parasympathetic pathway, from the sacral cord to the hypogastric ganglia. (2) Inhibition of the internal sphincter. This has been deduced from the fact that the sphincter opens and closes when required, even after division of the presacral (sympathetic) nerve. (3) Conveyance of afferent fibers for the micturition reflex. Micturition can be carried out normally after division of the presacral nerve; therefore, the reflex fibers must traverse the remaining (parasympathetic) pathway. (4) Conveyance of afferent fibers subserving such sensibility as the bladder possesses, for this is unaltered after sympathetic neurectomy.

A study of these functions shows that the sympathetic nerves are "filling" or "storing" in function (dilatation of bladder and closure of its sphincter), whereas the parasympathetic nerves are "empty-

ing" in function (contraction of bladder and opening of its sphincter).

#### SURGICAL CONSIDERATIONS

*Parasympathetic Nerves.* The parasympathetic nerves of the bladder are readily accessible only throughout their intraspinal course. Here they are sometimes subject to compression as a result of the congenital malformation termed spina bifida occulta. Not all patients with lumbosacral spina bifida occulta have symptoms referable to the bladder; but there is a group of young adults who may give a history of enuresis in childhood, and who may have urinary difficulty expressing itself in dysuria, perhaps urgency, and the presence of residual urine. With the cystoscope, the internal sphincter is seen to be relaxed, and the wall of the bladder to be finely trabeculated; it is found, also, that the bladder is hypesthetic and has lost some of its expulsive power. In a proportion of these cases, exploration of the spinal defect reveals compression of the roots of the sacral nerves, the relief of which leads to rapid restoration of vesical function; although why the pressure should affect only the visceral fibers in the sacral nerves is by no means clear. Among the compressing agents which may be found at operation may be mentioned fibrocartilaginous bands, masses of fibrofatty tissue, meningocele, and bony excrescences. In many cases, however, exploration for compression is negative; in these the spina bifida occulta is merely an accompaniment of a primary neurogenic defect.

*Sympathetic Nerves.* Sympathetic neurectomy has been undertaken at The Mayo Clinic in cases of three types:

1. *Paresis of the Musculature of the Bladder.* When a bladder is incapable of emptying completely as a result of injury to any portion of the parasympathetic pathway, it has seemed reasonable to suppose that the intact sympathetic contribution to vesical innervation provided too effective a brake for the decreased parasympathetic innervation, and that

after sympathetic neurectomy the diminished activity of the evacuant set of nerves would be unhampered by this brake. Operation has been carried out in eight cases of this type, one of which has been reported in detail elsewhere.<sup>1</sup> One patient in the series cannot be traced, and one failed to receive benefit. Of the remainder, two are considered cured (for periods of two years and one and a half years, respectively), and the expulsive power of the bladder, in the other four patients, has been materially improved; the amount of residual urine has been reduced from 200 to 300 c.c. to 20 or 30 c.c. It is necessary to warn men that after the operation, although they will be able to perform the sexual act and to experience a normal orgasm, ejaculation will not occur; no detectable alteration in reproductive function follows the operation on women. It has been found that after two or three weeks the internal sphincter of male subjects recovers a proportion of its tonus, although the trigone, bereft of its motor nerve supply, remains flaccid. A small quantity of residual urine may persist as a trigonal pool; in these cases a channel is made from pool to posterior urethra by the operating cystoscope, and this operation has often enabled the bladder to expel its contents completely.

2. *Spasm of the Neck of the Bladder.* In two cases in which there was difficulty in starting the flow of urine, a diagnosis was made of spasm, or better, achalasia, of the internal vesical sphincter. In both cases urologic and neurologic examinations were negative, and attempts had been made to rectify the condition by punch operations on the neck of the bladder. Because the sympathetic system provides motor nerves to the internal sphincter, it was thought that its overcontraction would be diminished by sympathetic neurectomy. The operation was immediately successful in both cases, and neither patient

<sup>1</sup>Learmonth, J. R., and Braasch, W. F. Resection of the presacral nerve in the treatment of cord bladder. *Surg., Gynec., Obst.*, 61: 494-499 (Oct.) 1930.

has had any subsequent difficulty in beginning or in completing the act of micturition.

3. *Inveterate Vesical Pain.* Since 1926, when Pieri first performed presacral neurectomy for the relief of vesical pain, a number of successful operations has been recorded. Pieri has devised a more complete procedure, which aims at interrupting all possible sympathetic paths from the bladder to the central nervous system (Fig. 2); this he considered necessary, because one or two fine branches may connect the hypogastric ganglia directly to the sacral paravertebral sympathetic ganglia (Figs. 1 and 2). The complete operation interrupts impulses which, after reaching the hypogastric ganglia, might pass by fibers traversing the paravertebral chains either to the sacral nerves by way of the rami communicantes, and so to the spinal cord, or, after ascending in the paravertebral chain, by way of lumbar or thoracic rami communicantes to the spinal cord at a higher level.

Among the conditions in which this operation has been tested at The Mayo Clinic are interstitial cystitis, inoperable carcinoma of the bladder, chronic cystitis of unknown etiology, and the irritability of the bladder which may remain after nephrectomy for renal tuberculosis. The result has been satisfactory in six of eleven cases. There has not been any marked difference between the result after simple presacral neurectomy, and that after the more extensive operation. The relief from pain is chiefly relief from the pain to which spasmodic and uncoordinated contractions of the musculature give rise. As has been pointed out, the parasympathetic pathway contains many, indeed the majority, of afferent fibers, so that relief of pain, at best, must be incomplete. However, after operation, these patients appear to respond better to local urologic treatment, and this has been directed to increasing the capacity of the bladder, which the operation does not directly do.

In conclusion, I must emphasize that in outlining our experience I am the spokesman of a group, which consists of urologists, neurologists, and urologic surgeons. The operations on the nerves of the bladder which I have described should be undertaken only after most careful and critical examination of the patient, whose preoperative and postoperative treatment must be carried out from all possible clinical angles.

#### DISCUSSION

DR. N. P. RATHBUN: My reaction to the matter is that these cases will have to be very carefully selected with the very careful cooperation of the neurologist and urologist, and that these cases will not be very great in number.

I have in my wards at the present time a relatively young woman, who, following an operation for some pelvic condition under spinal anesthesia four years ago, has had complete inability to urinate. She was offered some neurological operation, I presume it was resection of the presacral nerve, at another hospital. Her condition at present is so grave from renal infection and stasis that she is in no condition for any kind of surgery. I have another patient with paralysis of the bladder following repeated sacral anesthetics. I am wondering if such a case is suitable for the operation under discussion.

If the work that Dr. Learmonth is doing offers anything to a group of tabetic bladders, of which we all see so many, it will indeed be a Godsend. I have seen a number of these in years gone back where I have been driven to do a permanent cystostomy, which of course is an unsatisfactory operation, but which seemed to offer them more relief than any other thing that we could do.

DR. EDWIN BEER: Experience in this field is very limited, even in large institutions in the big cities. At Mount Sinai, only one case of presacral nerve excision has been done and that in a case of tabes without any improvement in expulsive force. Perhaps in this type of case the disturbance is in the centripetal fibers and naturally it would be foolish to expect any result.

In connection with cases of enuresis in the young and enuresis in adults, Dr. Learmonth has called attention to the finding of a band pressing the dural sac in the sacral region,

and after relief of the pressure by excision of this ligamentum (subflavum) the bladder condition was markedly benefited. These cases have been reported in the Continental literature by numerous writers on numerous occasions. Francois and Delbet have reported several series of satisfactory results. Legueu, on the other hand, has failed on laminectomy in these cases, associated with spina bifida, to even find such misplaced ligaments.

While enuresis in children is a common complaint and may be associated with non-fusion of the lamina of the fifth lumbar or first sacral, enuresis in adults is, in our experience, very rare. Marion in his clinic claims that only one case has been seen, and that a doubtful one, in over 150,000 admissions. In view of these contradictions and difficulty, the question arises, how and when shall we decide to interfere surgically? If a lipiodol intraspinal injection can demonstrate a block at the site of the vertebral pathology or injection through the coccygeal foramen, as recommended by Delbet, can demonstrate a block from below, naturally one can be under the impression that operation for compression of the dura may be indicated, but as yet very few such observations have been made. The recognition of a spina bifida of this type is so common that we hesitate to assign this pathology as the cause of some of the atypical or typical bladder disturbances.

In connection with these cases in children which for years we have been encountering and diagnosing as neuromuscular disturbances or disharmony between sphincter and detrusor, it is just possible that such an operation as has been described by the French (Rochet) and Dr. Learmonth combined may effectively control the spastic sphincter and make for more harmonious muscular expulsion. On the other hand, in the few cases that have come to operation, excision of a wedge at the neck of the bladder has seemed to control the condition completely, and others that were not operated upon, simple dilatations of the sphincter have been effective in establishing normal cooperation between the detrusor and the sphincter muscle.

In connection with stimulation of the detrusor muscle by drugs, Dr. Learmonth in his paper has spoken of the great value of acetylcholine, which we have tried, and with the bladder connected with a cystometer we have regularly failed to get any muscular contrac-

tion. Again other drugs have been equally unsatisfactory, except pilocarpin, which almost regularly produces an increase in pressure, due to detrusor contraction. Moreover in postoperative retention, pilocarpin is very effective. It would be most encouraging if some pre-operative test could be made by injecting drugs which would clearly show which cases are suitable for presacral nerve resection, which are suitable for hypogastric ganglion resection, and which are suitable for operations on the pudic system. Until further steps are made, in view of the fact that the general nervous system gives no evidence of disturbance in the majority of these cases, progress must be slow and careful so that patients are not unnecessarily submitted to operations of this sort, which will bring the whole experimental study into discredit.

DR. JAMES R. LEARMONTH, *closing*: Not only did stimulation of the central end of the cut presacral nerve give rise to painful sensations which were localized in the bladder wall, but also there was not any complaint of pain referred to the twelfth thoracic and first lumbar segments; these are said to be the somatic segments associated with the pain of overdistension of the bladder.

With regard to Dr. Beer's questions: I have not operated on any patient whose only complaint was enuresis. My patients may have had a history of enuresis in childhood, but the condition which determined operation was paresis of the bladder. Like Dr. Beer, I have been disappointed that in these cases the epidural injection of lipiodol gives little help in determining the presence or absence of compression of the cauda equina. In such cases I think it worth while to explore the region of the spina bifida occulta, and if dural sac compression is present, to relieve this.

I have not, myself, operated on patients whose difficulty in micturition was due to tabes. In such cases, the lesion is probably in the afferent pathway, and one would not expect section of the presacral nerve to help.

The cases most suitable for resection of the presacral nerve are those in which there is evidence of over-balance of the filling or storing set of nerves (sympathetic) to the bladder. These nerves play a part in carrying out the function assigned by Bernard to the whole sympathetic system: regulating the composition of the body fluids.

# VESICAL DIVERTICULUM IN THE FEMALE\*

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PRIOR to the beginning of the present century, bladder diverticula were only found at the operating table and at post-mortem examinations. Tremendous improvements in modern urological methods of examination have enabled the operator to recognize this condition.

By diverticulum of the bladder, is meant a protrusion, or herniation, outwards, of a part or of the entire wall of the bladder. As a result of this protrusion, a cavity is formed which connects with the interior of the bladder.

Diverticula of the bladder are more frequent than is commonly believed. They are less frequently found in the female. The ratio in females, as compared to males, is about 3 to 97.

There is still a great deal of controversy as to whether diverticula are of congenital origin or acquired. Some authorities believe that as a result of maldevelopment in the muscle fibers of this structure in the embryo, there is a congenital weakness. As a result of this congenital weakness, with subsequent stress and strain of life, herniation occurs.

These problems are purely of academic interest and rarely of any significance in reference to the clinical or surgical problem. It should be borne in mind, however, that obstruction to the urinary outlet is an important factor in the formation of diverticula.

Diverticula are most commonly found when such an obstruction exists, and it is perhaps because of this reason that the condition is most frequently found in the male. At one time it was believed that true diverticula could only be found in males and usually only after middle age. This belief has been repeatedly proved to be

false. In addition to the condition being found in females, it is often encountered in children and young adults. As a rule, however, diverticula are most often found beyond the age of forty.

Diverticula may be found in any location within the bladder. The most frequent location is that of the posterial lateral walls near the ureteral orifices. It is less frequent on the lateral walls and least frequent on the dome. Diverticula found on the dome are usually undoubtedly due to a persistence of the urachus. This type of diverticula can be truly called congenital in nature.

Occasionally, as in the case herewith reported, diverticula may undermine the trigone. They occur most frequently singly but may be found in multiple numbers, as in the case reported. There have been cases reported in which a dozen or more diverticula were found.

A common complication of diverticula is infection. It can be readily understood how extension of infection of the bladder to the interior of a diverticulum may occur. Favored by the anatomical arrangement of such a sac, the infection may become persistent and chronic in nature.

Frequently such infection may extend to adjacent structures with subsequent formation of a peridiverticulitis. This explains the frequent findings of fibrous adhesions to either the rectum, wall of pelvis or other adjacent structures.

Formation of calculi, neoplasms, benign or malignant, pressure on ureter and hemorrhage, are other complications frequently encountered. As stated before, such factors of obstruction either at the vesical outlet or in the urethra are pathological findings of great significance.

\* From the Department of Urology, Flower Hospital. Submitted for publication July 7, 1931.



In the female such simple pathology as a urethral caruncle has been a frequent finding. In a case reported, this was the first hint of any vesical abnormality existing.

*Symptoms:* The bladder diverticula may cause no symptoms whatsoever. With infection of the bladder or complications such as vesical calculus or tumor, symptoms become more apparent.

It is the general consensus of opinion that no one symptom is pathognomonic of diverticulum. Disturbances of micturition are usually the first indication of any pathology being present. This is often obscure in the early stages and commonly overlooked. The disturbance may be present at the beginning, during or after micturition.

Difficult urination, frequency and hematuria are signs often indicative of diverticulum, but are of no diagnostic value since these disturbances are frequently found in other bladder conditions.

A very suggestive sign in this condition is that of a very foul urine. The French speak of a pathognomonic sign, the so-called "pis deux." This is not always present but when present should immediately arouse one's suspicion of a bladder diverticula. The patient will void urine and think he has completely emptied his bladder. To his surprise and usually following a change of position, he will shortly void a large amount of very foul urine. This phenomena is explained by the sudden emptying of the diverticulum into the vesical cavity.

Retention, partial or complete, frequently occurs as well as incontinence. As a rule, retention results due to the pressure of the diverticulum on the bladder neck. In the case reported, retention existed undoubtedly due to obstruction in the urethra. Frequently, where retention exists, the diverticulum will produce a serious clinical picture with chills, fever and prostration. Such condition requires immediate surgical intervention.

In general, it may be said that the symptoms of diverticulum are those of its

complications. Symptoms always appear when infection sets in and we are dealing with a diverticulitis. Further, unless complications set in, the diverticulum is symptomless and undoubtedly harmless.

*Diagnosis:* After a careful history taking and physical examination, it becomes necessary to confirm the diagnosis of diverticula by cystoscopic examination. This is a comparatively simple procedure and only in rare exceptions can such pathology be overlooked. It is of interest to note in this respect that recent literature on this subject warns against overdistension of bladders with multiple diverticula and against unnecessary manipulation. The potential danger of rupture of the bladder is far greater in these conditions than in the normal bladder in a routine cystoscopic examination.

Cystoscopic examination reveals the number and location of the diverticula. It does not, however, give any information as to the size, shape or capacity of the herniation. By means of cystography, we can ascertain the size and extent of the diverticula.

Cystograms are easily obtained and the procedure is indeed a simple one. Sodium iodide (or any of the opaque substances) is most commonly used, though some urologists claim air cystography to be superior. Others resort to the passage of x-ray catheters into the diverticulum.

At Flower Hospital we use 20 per cent sodium iodide and find the results most satisfactory. At times, due to the peculiar position of the diverticulum, it may sometimes be necessary to take more than two exposures and at different angles. We always take a plate before filling and one after emptying of the bladder. It is of interest to note at this point that in cases of intravenous pyelography, fairly accurate cystograms are obtained after the dye has been excreted by both kidneys and reaches the bladder.

*Treatment:* Diverticula of the urinary bladder can only be treated by means of surgical intervention. Non-surgical meth-

ods of treatment are of no value whatsoever and should only be resorted to when operative procedure is definitely contra-

#### REPORT OF CASE

The following case is reported because of its occurrence in the female with definite signs

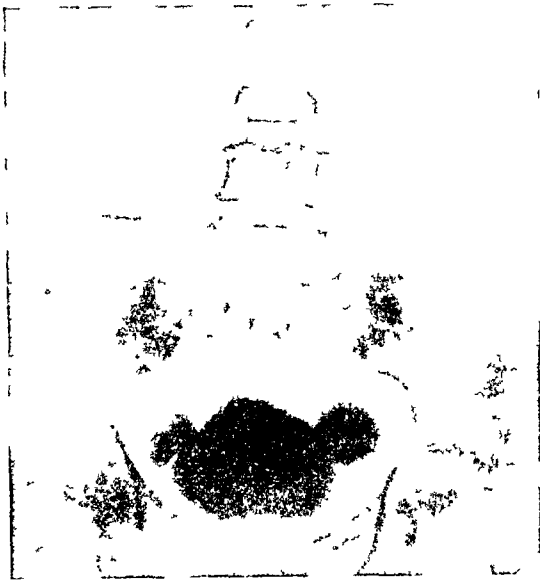


FIG. 1. Cystogram of case reported. Only lateral diverticula are seen.

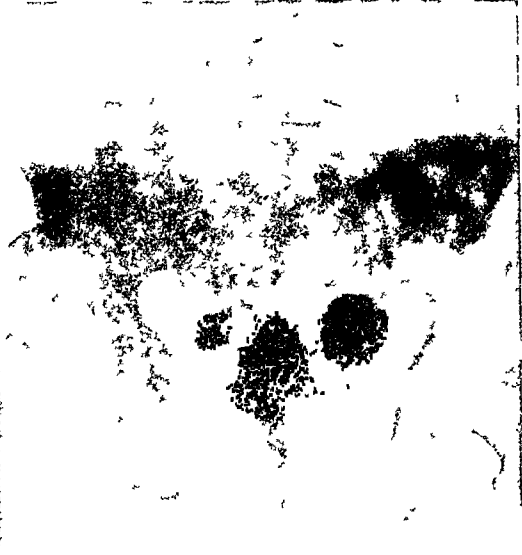


FIG. 2. Same as Fig. 1, showing retained iodide in diverticula and retrograde movement of iodide up ureters.

indicated. This is determined by the general status of the patient, taking into consideration age, general physical condition and the extent of surgery necessary to correct the deformity. Poor general health, senility, heart disease or advanced pulmonary disturbances, impaired renal function and marked urinary infection often prohibit surgery or make its procedure extremely dangerous.

In the past there have been various surgical procedures recommended, such as suturing of the orifice of the diverticulum without excision of the sac; enlargement of the orifice of the sac; or radical excision of the diverticulum. It is now the general opinion among most surgeons that complete excision is the only satisfactory procedure.

It must always be borne in mind that if complete cure is to be hoped for, it is necessary that whatever obstruction exists, the cause of such obstruction, as well as the obstruction, should be removed.

of obstruction as a possible explanation of the causative factor.

C. J., female, age sixty-three, brought to the hospital by ambulance with complaint of being unable to void.

About twelve years ago she first complained of irritation and burning on urination. In order to urinate patient had to stand. She was formerly hospitalized in Porto Rico, where a growth was noticed at the urethral meatus. This was not treated at the time "for fear of malignancy."

Two months ago patient had a severe attack of hematuria, which subsequently subsided. This is the only history of hematuria that she gives. Her urine has been particularly offensive and foul in the past three months.

Family history is essentially negative. No childhood diseases, a history of rheumatic fevers and attacks of pain in the extremities between the ages of ten and twelve.

Physical examination reveals a thin, somewhat emaciated elderly female, apparently comfortable and with no complaint of pain. Physical examination was essentially negative with the exception of the distended bladder,

which reaches the level of the umbilicus. Furness catheter was passed with some difficulty. At the urethral meatus a papillary raspberry-like growth was seen.

In view of the somewhat vague history concerning the possibility of the urethral growth being malignant, a biopsy was performed. Subsequent pathological report revealed it to be epithelial hyperplasia with chronic granulomatous inflammation (caruncle).

The following day a cystogram was made of the patient, using 20 per cent sodium iodide, which revealed a markedly irregular bladder, with one large diverticulum on the left side and two smaller diverticula on the right side. Following emptying of the bladder, these sacs retain the iodide.

At this time it was noted that there was a retrograde movement of the iodide up the ureter, and an attempt was made to obtain a complete pyelogram by means of a marked Trendelenburg position and overdistension, but this procedure failed.

Subsequent cystoscopy revealed marked papillary cystitis over the entire floor of the bladder, most marked in the region of the trigone. Marked trabeculations were noted. The right and left urethral orifice were visualized without any difficulty.

There was a large diverticulum on the lateral wall of the bladder to the left of the orifice. Two smaller diverticula were seen in the right half of the trigone.

Under general anesthesia routine suprapubic cystotomy was performed. Bladder and diverticula were exposed. The two lateral diverticula were removed with ease. The cavity undermining the trigone was exposed and

removed with difficulty. Method of procedure consisted of packing diverticulum with gauze and by blunt dissection sack was removed at the neck. Remaining orifices were sutured; No. 0 chromic for mucous membrane and No. 1 chromic for muscle were used. Cigarette drains were placed on right and left side of bladder. Bladder was closed in routine manner with suprapubic retention catheter sewed to skin with black silk.

Postoperative care consisted in the routine management similar to all surgical bladder procedures. In addition, the caruncle was completely destroyed by the fulgurating current. The urethra was gradually dilated by means of straight female sounds, up to a No. 26 F. Urine was passed freely without any odor or sign of infection.

*Conclusions:* This case is reported because of the common belief that large, multiple or true diverticula are seldom found in the female. Secondly, because of its association with the urethral caruncle as a factor of obstruction.

It should be noted that in reported cases of vesical diverticula in the female, 90 per cent of them have been associated with urethral caruncle. It therefore follows that females with urethral caruncle of long duration and some vesical disturbance should be investigated for possible diverticula of the bladder.

I am greatly indebted to my chief, Dr. Louis René Kaufman, for his valuable aid and permission to report this case.

#### REFERENCES

- LEWIS, D. Practice of Surgery. Vol. 9 (Author).  
 EISENDRATH and ROLNICK. Urology. N. Y., Lippincott, 1929.  
 BRAASCH. Urography. Phila., Saunders, 1928.  
 SCHACHT, F. W., and CRENSHAW, JOHN L. Vesical diverticulum in the female. *J. Urol.*, 4: 393, 1930.  
 EISENSTAEDT, J. S., and McDOUGALL, T. G. Bladder diverticula. *J. A. M. A.*, 11: 831, 1931.  
 LOWER, W. E. Diverticula of the urinary bladder. *Surg. Gynec. Obst.*, 52: 324, 1931.  
 HINMAN, F. The etiology of vesical diverticulum. *J. Urol.*, 3: 207, 1919.  
 POLKEY, H. J. Diverticula of the urinary bladder. *Urol. & Cutan. Rev.*, 31: 73, 1927.  
 KRETSCHMER, H. L. Diverticulum of the bladder. *Surg. Gynec. Obst.*, 48: 404, 1929.  
 ROSENTHAL. Diverticula formation. *Arch. f. klin. Chir.*, 144: 404, 1927.  
 KRETSCHMER, H. L. Demonstration of bladder diverticula. *Surg. Gynec. Obst.*, 34: 538, 1922.  
 LOWER, W. E., and HIGGINS, C. C. Diverticula of the urinary bladder with report of 110 cases. *J. Urol.*, 22: 635, 1928.



# SO-CALLED ESSENTIAL HEMATURIAS

ARE THEY CHIEFLY DUE TO URETERAL STRICTURE?\*

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RENAL hematuria has long been one of the problems of interest in the diagnosis of abdominal conditions. If we adopt the generally accepted view of today that most kidney bleeding, unassociated with such gross lesions as tumor, tuberculosis, or stone, is due to nephritis or nephritic-like processes, we are still confronted with at least two questions: (1) Why do not all kidneys bleed when they become subject to these organic changes? and (2) What is the mechanism concerned in those kidneys which do bleed?

In the early days of this century Israel,<sup>1</sup> after a ten-year study of the problem came to the following conclusion:

The result of the analysis of my 14 cases of so-called *néphralgie hématurique*, essential and angioneurotic kidney bleeding, is that there can be shown in most of them organic changes in the kidney or its capsule, or an abnormal mobility.

In 1918 Strauss<sup>2</sup> agreed with Israel that the hemorrhage is due to a lesion in some minute vessel, and he believes that the change from a "drip" or microscopic bleeding to a "massive" or macroscopic bleeding is due to an increase in the intrarenal pressure.

Although there may be others, the most frequent causes which bring on a temporary intrarenal increase of pressure are rigidity of the capsule wall and compression and strangulation processes at the renal pedicle.

In 1922 I<sup>3</sup> attempted to show that ureteral stricture with its urinary stasis is probably the most important factor leading to increase in intrarenal pressure. I held that stricture with its back pressure is not only the important factor in the immediate

attack of renal colic (when present and not due to the passage of clots) and vascular injury, but that by long continued back pressure it has often contributed to the interstitial nephritis present in these cases.

I also attempted to show that focal infections probably play a most important rôle in many of these cases of so-called essential hematuria. Not only do focal infections cause many of the ureteral inflammatory processes resulting in stricture, but in all probability they also cause direct injury to the kidney, resulting in the nephritic-like areas and at times causing a persistence of the bleeding after apparently good kidney drainage has been obtained through wide dilatation of the ureteral stricture. In some of our cases the bleeding has ceased only after a focus of infection has been cleared up. This may mean that the persistent bleeding was due to continued direct injury to the kidney tissues by the focal infection, or that the focal infection kept up an inflammatory reaction in the stricture area, thus resulting in continued back pressure in the pelvis in spite of our apparently satisfactory dilatations.

This leads to the second question: What is the exact mechanism of the bleeding? I think we get our most satisfactory explanation of this phenomenon by referring to the experimental work of those who have studied the problem of "pelvic reabsorption." Hinman and Lee-Brown<sup>4</sup> found by experimenting on living anesthetized animals that they could obtain a pyelovenous backflow by raising the intrapelvic pressure to a point even less than that of the normal secretory pressure for

\*From the Department of Gynecology, Johns Hopkins University and Hospital, Baltimore, Md. Read before the Urological Section of the New York Academy of Medicine, October 15, 1930.

the given species. They found that the pelvic rupture would occur in the angle of the deep sulci of the minor calices, and

with the phenomena of pain and bladder symptoms, with the development of bleeding from the remaining kidney after a nephrectomy

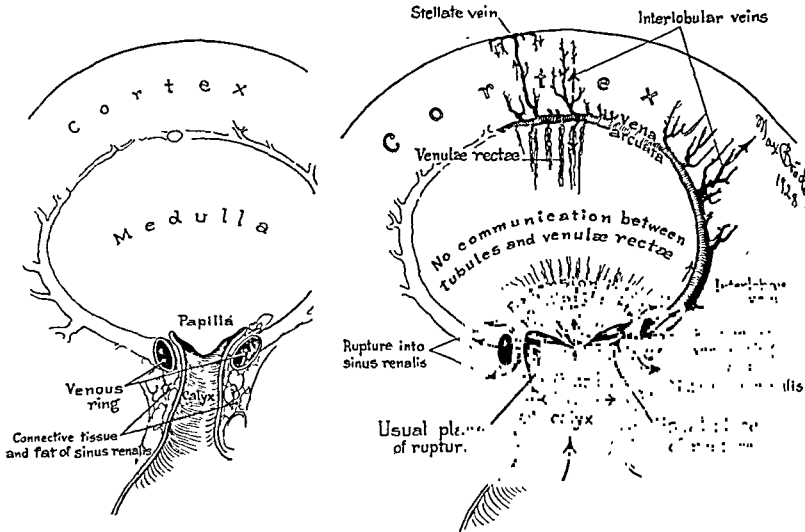


FIG. 1. Mechanism of pyelovenous backflow according to Dr. H. F. Traut.

they thought the backflow took place into the venulae rectae. Traut,<sup>5</sup> working on human autopsy material, found that the rupture in the deep sulcus more often occurred directly into one of the large veins of the inner arcuate system (Fig. 1). He made the significant observation that the low tension ruptures (those at a manometric pressure of less than 100 mm. of mercury, i.e., the normal secretory pressure in the human kidney) occurred only in kidneys taken from a delayed autopsy (thirty-six to forty-eight hours) in which autolytic changes had supervened, or in those kidneys which, though appearing normal at autopsy, were found on microscopic examination to be the seat of nephritis.

The notable array of pathological changes which we have found in the upper urinary tract in our studies on ureteral stricture, and the value of ureteral therapy in the treatment of these conditions, prompts one to turn to the ureteral domain in seeking an explanation for many of the controversial points associated with the subject of essential hematuria.

Some of these controversial questions have to do with the various phases of nephritis,

for bleeding, with the questions concerning papillitis, varicosities and apparent angiomas about the papillae, pyelitis follicularis, undue mobility of the kidney, twisted pedicle, shrunken capsule, and passive congestion. Some of these questions were discussed at some length in our previous publication, and with special reference to their relation to the ureteral problem.

Israel thought that unilateral nephritis is not rare and might account for the cases of unilateral hematuria, but Kotzenberg,<sup>6</sup> Kummel,<sup>7</sup> and Strauss all take issue with Israel and believe that the nephritis is practically always bilateral. In dealing with stricture cases we sometimes find pathological elements, such as albumin, casts, erythrocytes or leucocytes, coming from one kidney only, and from this we might conclude with Israel that these are instances of unilateral nephritis. Experience has shown, however, that stricture is almost always bilateral, and more careful investigation of the supposedly normal side in such cases reveals tenderness to palpation, definite evidences of stricture by the bulb investigation, and evidences of changes in the upper tract above the stricture area on urogram tests.

Hinman and Lee-Brown recognize the possibility that some of our clinical hematurias are due to intermittent hydronephrosis, but in carefully devised experiments they were unable by venous injections to get a clear-cut reversal of the pyelovenous backflow. "There occurs,

under conditions of moderate intrapelvic pressure, a backflow of pelvic contents into the renal veins. The degree of back pressure

It is practically impossible, however, in experimental work to reproduce the conditions which we find clinically in patients



FIG. 2 (Case 1). Note enlarged pelvis with filling defect on median border. Note dilated ureter down to a point below pelvic brim.



FIG. 3 (Case 1). Right urogram taken during convalescence. Catheter entirely withdrawn, pelvis and ureter holding 27 c.c. NaI. Note retention area in ureter at point about 6 cm. above ureteral orifice.



FIG. 4 (Case vi). Note very slightly dilated ureter and calices, almost complete lack of x-ray evidence in a ureter which had given serious intermittent trouble for four years, and for which nephrectomy had been advised.



FIG. 5 (Case vi). Note slightly dilated ureter from a point 2 cm. above bladder to kidney. No symptoms on this side, but better x-ray evidence of trouble than shown by Fig. 4.

producing it is generally less than renal secretory pressure and, the communication once established, a pressure lower than the initial one keeps it going. *Curiously, relief of pressure is rarely, if ever, followed by hemorrhage.*"

subject to renal stasis such as that caused by ureteral stricture. We know that drainage conditions in stricture patients alter from hour to hour or from day to day. It is characteristic in the early development of stricture in many women that the only period when they show

evidences of stricture, such as renal backache, renal colic, slight fever, frequency of micturition, or renal hematuria, is for a few days at

patient suffers from intermittent renal attacks only after getting the feet wet, getting chilled, taking a long cold automobile ride, during an



FIG. 6 (Case xiv). Note stricture area in broad ligament region with marked dilatation of ureter and moderate dilatation of calices.



FIG. 7 (Case xiv). Note about the same features as in Fig. 6.



FIG. 8 (Case xvi). Note relatively narrow area in upper abdominal ureter. Hydronephrosis 23 c c.



FIG. 9 (Case xvi). Note relatively narrow area in upper abdominal ureter. Hydronephrosis 18 c c.

or near menstruation. Either immediately preceding, during, or just after the menstrual epoch it seems that added congestion in the stricture areas brings about sufficiently greater interference with drainage to aggravate signs and symptoms only slight or totally lacking at other times.

In some stricture patients the ureters seem to function well for weeks or months and the

attack of tonsillitis, sinusitis or toothache, or after surgical interference for any of these conditions.

Is it not reasonable then to explain the intermittency of bleeding in many of these hematuria cases on the theory of intermittent ureteral stasis of a degree sufficient to cause pyelovenous backflow. The prompt cessation of bleeding in most of them as soon as we dilate

sufficiently to give good ureteral drainage affords further confirmation of the causal relation between stricture and hemorrhage,

2 to 3 mm. diameter, a bulb placed near the tip of the catheter is likely to demonstrate actual organic narrowing.



FIG. 10 (Case xviii). Note slightly deformed pelvis and lower calices, and incompletely filled but slightly dilated ureter down to an area about 3 cm. above bladder.



FIG. 11 (Case xviii). Note incompletely filled but slightly dilated ureter down to an area about 2 cm. above bladder.

and corresponds with Hinman's experimental observation that relief of pressure is rarely, if ever, followed by hemorrhage.

Many of these patients, it is true, return with bleeding perhaps weeks, months, or years after we have established ureteral drainage, but investigation then shows that the stricture areas have contracted, and further dilatation again brings about cessation of bleeding.

The urologist must remember that one source of failure in relieving any symptom due to ureteral stasis is the overlooking of strictures in the upper ureter. I formerly thought that high strictures are rare, but I have since found that many relative failures in dealing with stricture, both in my own work and in that of others, have been due to the fact that although strictures in the lower ureter had been well dilated, those in the upper ureter had been overlooked and dilated only by the width of the catheter (see Figs. 8 and 9).

If the urogram shows a widely dilated ureteral lumen extending from a low stricture area to the kidney, one may work with the dilating bulb in the usual position 10 cm. behind the catheter tip; but should the urogram show relative narrowing of the upper ureter, this may be due to incomplete filling or to a local peristalsis. On the other hand, if this relative narrowing persists in more than one film, even though it appears to be of the normal

Of course one must be constantly on the alert for other factors that may cause stasis in the upper ureter, such as an abnormal angle of insertion at the pelviureteral junction, lateral pressure exerted by a hydronephrotic pelvis, undue mobility of the kidney with the upper ureter held in good position by periureteral adhesions, and compression of the upper ureter by infiltrated peripelvic fat.

The literature is replete with illustrations of the so-called ureteral "kinks" leading to nephropexies and other operations, while the authors say not a word about the cause of the widely dilated portion of the ureter showing below the kink. Usually these x-ray kinks are of good prognosis, since they may merely indicate that the upper ureter, which has dilated in length as well as in width, is prolapsing *pari passu* with the kidney, and that removal of the obstruction in the lower ureter will restore good drainage.

Bumpus<sup>8</sup> apparently questions the generally accepted theory that these hematurias are due to a nephritis, on the ground that a review of the cases treated in the Mayo Clinic shows such a large proportion of the patients in apparent good health for years after their period of hematuria.

In our ureteral stricture work we meet with patients with apparently serious damage to their kidney tissues due to the ureteral stasis, which has resulted in bilateral hydronephrosis,



in infection of one or both pelves, in bilateral nephritis with pelves smaller than normal, or in bilateral calculus of an extreme grade.

The proposed new viewpoint on the so-called essential hematurias has had the reception one expects for any idea that promises a



FIG. 12.

FIG. 13.

FIG. 14.

FIG. 12 (Case xx). Moderately enlarged and deformed kidney pelvis and calices. Dilated ureter with narrow area just above slightly filled ballooning sac at ureterovesical region.

FIG. 13 (Case xx). Better filling of ballooning sac with narrow area just above. It is probable that the narrow area represents site of a stricture symmetrical with stricture found on left side, and that the dense infiltration of ureteral os resulted in dilatation of entire tract above, thus preventing a 5 mm. bulb from picking up stricture area in juxtavesical region.

FIG. 14 (Case xx). Catheter withdrawn until bulb hangs in a stricture area 3 cm. above ureteral orifice. Note moderate dilatation of tract above stricture area, with relatively wider dilatation of upper and lower calices.

These patients may have a two-hour phenol-sulphonphthalein output in the neighborhood of 10 per cent, and yet, after restoration of good ureteral drainage and employment of the appropriate renal treatment, these patients not infrequently develop a two-hour phenol-sulphonphthalein output of more than 50 per cent and live for many years in surprisingly good health, some of them even carrying pregnancies through to a successful issue.

Surely one would not argue from these facts that the kidneys of such patients were not suffering from nephritis or nephritic-like processes in the days of their treatment; nor would one argue that because the urinalysis seems perfectly normal ten years later these kidneys would not show old pathological changes.

Bumpus states: "That the disease can hardly be of nephritic origin, as *nephritis is usually understood*, seems clear in this study." The phrase which I have italicized scarcely saves the argument, for in spite of the volumes published on nephritis there are few terms in medicine about which we have such vague and contradictory ideas.

revolution in traditional methods of dealing with a serious situation. Personal communications from men working at stations scattered over the entire globe have shown that others are having gratifying results by using the methods suggested, but so far as I know, Livermore<sup>9</sup> is the only other worker who has published a report on cases of hematuria due to stricture. The attitude of the leading urologists, who should be the first to investigate any method promising such possibilities of conservatism, in dealing with a situation hitherto but little understood, has been one of indifference. This is perhaps best illustrated by the fact that my five minute discussion before the American Urological Association at its New York City meeting in 1918 (where, in a symposium on essential hematuria, I first presented urograms on a series of cases successfully treated by ureteral dilatation), was apparently considered of such fairy tale quality that it was entirely eliminated from the published records of that meeting. Ten years later, and six years after my first formal publication, the publication by Bumpus mentioned before, who makes a fairly exhaustive review of the literature on

the theories concerning the etiology of essential hematuria, completely ignores the ureteral stricture theory.

Hoping that the assembling of further data on this controversial subject may possibly stimulate careful investigation by some of the more conservative of the urological group, and knowing that it will encourage those who are already using the methods advocated, this paper is presented for the purpose of bringing my studies on hematuria up to date.

In the ten years from June, 1920, to June, 1930, I find 200 cases indexed under hematuria, after excluding a few cases which overlapped on this period and were reported in my first paper.

Two in this list of 200 were particularly interesting cases occurring in the practice of my associates; with one patient I came in contact in consultation and with the other merely in a discussion of the urograms. In some of the dispensary cases the care of the patient was entirely in the hands of the house staff.

Stricture of the ureter was found in 174 of our 200 cases of hematuria. In 22 cases examination of the ureters was not made, either because the source of the hematuria was so obviously of bladder origin or because investigation was refused.

In 4 cases examined for possible stricture this lesion was not found. In 1 of these, a patient with exophthalmic goiter, the urine showed microscopic pus and blood but we could find no lesion of the urinary tract to account for these pathologic elements. In one a primary ureteral papillocarcinoma was found. In one an edema of the trigonum was found and the bulb test showed infiltration of the bladder wall. In the fourth case, that of a thirteen-year-old child, there was great hypertrophy of the bladder walls, vesicoureteral reflux with considerable dilatation of the ureters and pelves, but the diagnostic bulb revealed no hang. While the bilateral colon bacillus pyelitis improved after wide dilatation and repeated pelvic lavage, the bleeding did not cease until bad tonsils had been removed. The macroscopic hematuria coming from the left kidney had been present constantly for thirteen days before our first investigation and for another twenty-five-day period during our dilatation and lavage treatment, and within four days of the tonsillectomy there was a brisk hemorrhage from the left

fauces resulting in a drop of blood pressure from the former level of 210/160 to 165/120. The bleeding from the throat was promptly



FIG. 15 (Case XXIII). Urogram with catheter out. Note stricture area about 3 cm. above bladder with moderate dilatation of tract above.

stopped with a suture and within a few days the old level of hypertension was regained; but from the time of this hemorrhage the blood in the urine ceased. This leaves us with the question as to whether the tonsillectomy or the postoperative hemorrhage with its consequent sudden fall in blood pressure was the deciding factor in curing the renal hemorrhage. Two and one-half years later the report shows that the child still has a blood pressure of around 200/130 but that she had been attending school and is in fairly good condition. The urine shows a specific gravity of 1013, and contains a trace of albumin and a few leucocytes. Blood has not been found microscopically since her return home.

Of the 174 patients in whom ureteral stricture was demonstrated, calculus in the upper tract was a complication in 37, tuberculosis in 8, and renal tumor in 2 cases. Of the 8 hematuria cases associated with tumor, in 3 hypernephroma was found, 2 of these patients also having ureteral stricture, as just mentioned. One had a primary papillocarcinoma of the ureter, and 4 had a bladder tumor.

When ureteral stricture is present with stone, tuberculosis, or tumor of the upper

tract, no one can say what share the stricture has in the hematuria.

The hematuria was ascribed to a pyogenic

Chronic pyelitis and hydronephrosis are recognized as common complications in the so-called essential hematuria cases, and



FIG. 16 (Case xxiv). Right kidney and ureter holding 24 c.c. NaI. This side held 50 c.c. four years previously. Note outline of a shrunken right kidney.



FIG. 17 (Case xxvii). Left urogram with catheter removed. Note moderate dilatation of ureter from stricture area (3 cm. above bladder) to kidney. Normal-appearing pelvis, slightly enlarged and clubbed calices.

cystitis in 23 cases, although 15 of these patients were found later to have stricture associated with the cystitis. Of the 13 patients with interstitial cystitis or elusive ulcer it so happened that all of these were found to have bilateral stricture, and in some of them we demonstrated that the bleeding was coming from the upper tract rather than from the bladder. It is characteristic of the elusive ulcer that, although microscopic blood can usually be found, this type of ulcer seldom gives rise to a macroscopic hematuria. If, therefore, one is dealing with a patient who gives a history of macroscopic hematuria, and the only evident lesion is an elusive ulcer which is not bleeding actively when examined, one should not fail to investigate for possible ureteral stricture.

A history of a former pyelitis was obtained in 7 cases, 4 of these supposedly bilateral. Pyelitis was found to be present in 25 cases, 16 of these being bilateral. A hydronephrosis of 10 c.c. or more was recorded in 65 cases, 16 of these being bilateral.

I hardly need emphasize that in the large majority they are due to ureteral stricture.

In résumé, then, we may subtract from our 174 cases of demonstrated ureteral stricture the cases with the following complications as a possible or probable cause of the hematuria: stone 37, tuberculosis 8, tumor of the upper tract in which stricture was found 2, elusive ulcer in which stricture was found 13, pyogenic cystitis or ulcer in which stricture was found 15, a total of 75 cases. This leaves 99 out of the 200 cases of hematuria in which stricture of the ureter was the only lesion found to account for the blood in the urine.

I realize that some will not agree that the 25 cases of demonstrated pyelitis, and 65 cases of hydronephrosis, in all of which ureteral stricture was demonstrated, may be ignored as having complications which cause the so-called essential hematuria. Fourteen of the 25 cases in the pyelitis group also belonged to the hydronephrosis group, and I am convinced that time will demonstrate the truth of my contention that these complications, like the

TABLE I

TABLE 1

No.	Patient	Age	Para	First Consulted	Hematuria						Treatment				Results		
					Duration	Con- tinu- ous	Inter- mit- tent	Gross	Microscopic		Operations	Ureteral Dilatations			Ceased	Continued	
									Re- ported	(Right Kid- ney		Right Side	Left Side	Size Times Fr.			Size Times Fr.
															Found		
i	Mrs. E. A.	28	..	Nov. 1929	20 days	+	..	+	+	+	Nephrotomy L.	..	..	1	11	1 year	
ii	Mrs. A. B.	26	2	June 1926	2 years	..	+	+	+	..	Nephrect. L.	17	18	7	..	4 years	
iii	Mrs. E. B.	35	1	Dec. 1925	2 years	..	..	+	+	..	.....	7	18	9	16	5 years	
iv	Mrs. M. B.	32	8	May 1930	6 years	..	..	+	+	+	.....	4	15	6	15	4 months	
v	Mrs. H. deC.	26	..	Nov. 1925	4 days	+	+	+	+	+	.....	7	15	2	4	4 years	Tuberculosis of right kid- ney and bladder appar- ently developed after 4 years
vi	Mrs. M. E.	39	..	Jan. 1926	4 years	..	+	+	+	..	.....	4	17	7	16	4 years	
vii	Mrs. G. G.	37	2	Feb. 1926	18 months	..	+	+	+	+	.....	2	16	2	16	3 years	
viii	Miss T. H.	20	..	July 1929	3 years	..	+	+	+	..	.....	3	16	3	16	18 months	
ix	Mrs. F. H.	36	2	Nov. 1922	3 years	..	+	+	+	..	.....	..	..	5	17	8 years	
x	Mrs. F. H.	32	0	May 1920	6 years	..	+	+	+	..	.....	2	14	..	..	8 year	
xi	Mrs. K. K.	36	0	Jan. 1920	5 months	..	+	+	+	..	.....	1	14	..	..	6 years	
xii	Mrs. S. K.	29	2	Apr. 1930	2 weeks	..	+	+	+	..	.....	5	17	3	14	8 months	
xiii	Mrs. A. L.	41	0	June 1927	17 years	..	+	+	+	..	Nephropey	12	17	11	17	1 year	
xiv	Mrs. F. M.	33	0	Nov. 1929	2 days	+	..	+	+	+	.....	6	16	4	15	1 year	
xv	Mrs. M. M.	30	4	June 1930	3 months	+	..	+	+	+	.....	3	14	3	17	On admission Hb. 60 per cent, r.b.c. 2,700,000. Condition improved but bleeding continued. Patient ceased coming.	
xvi	Miss N. McC.	36	..	Sept. 1922	2 years	..	+	+	+	..	.....	9	17	9	18	3 years	

Tuberculosis of right kidney and bladder apparently developed after 4 years

TABLE I (Continued)

TABLE 1 (Continued)

No.	Patient	Age	Para	First Consulted	Hematuria					Treatment					Results			
					Duration	Con- tinu- ous	Inter- mit- tent	Gross	Microscopic		Right Kid- ney	Left Kid- ney	Operations	Ureteral Dilatations			Hematuria	
									Re- ported	Found				Right Side Times	Left Side Times	Size Fr.		Ceased
xvii	Miss E. N.	20	..	Jan. 1924	+	..	+	+	+	+	..	.....	6	14	6	14	2 years	Then intermittent hematuria 4 years to Nov. 1930. A few long interval treatments elsewhere. Possibly insufficient dilatation
xviii	Mrs. E. O.	31	2	Oct. 1924	..	+	+	+	+	..	..	.....	3	16	1	11	6 years	
xix	Mrs. S. R.	35	3	Nov. 1925	..	+	+	+	+	..	..	.....	..	..	2	15	Letter May, 1930 says, "Still having same symptoms but cannot stand the treatments"	
xx	Mrs. B. R.	36	6	May 1929	..	+	+	..	+	..	..	.....	2	15	2	14	18 months	
xxi	Mrs. C. R.	66	4	May 1929	..	+	+	+	+	..	..	.....	4	17	4	17	18 months	
xxii	Miss C. R.	65	..	Oct. 1929	..	+	+	+	+	..	..	.....	14	12	13	11	Intermittent treatments 1 year, greatly improved but still microscopic bleeding. Died—Diphtheria	
xxxiii	Mrs. M. S.	55	2	May 1929	..	+	+	+	+	..	..	.....	8	17	7	17	1 year	Then symptoms including hematuria returned. Recent treatments, hematuria ceased
xxiv	Miss S. S.	77	..	Oct. 1922	..	+	+	+	+	..	..	.....	6	17	4	15	3½ years	
xxv	Miss A. T. S.	28	..	Apr. 1924	..	+	+	+	+	..	..	.....	7	17	6	17	6 years	
xxvi	Mrs. N. W.	32	1	Nov. 1928	..	+	+	..	+	..	..	.....	3	15	3	16	2 years	
xxvii	Mrs. Y.	49	2	Mar. 1930	+	..	+	..	+	..	+	.....	..	..	4	15	9 months	

hematuria, are merely secondary to the stasis caused by the stricture.

Of these 99 patients (in whom stricture

cessation of bleeding but not enough to relieve the patient of other symptoms.

In several of those for whom the chart

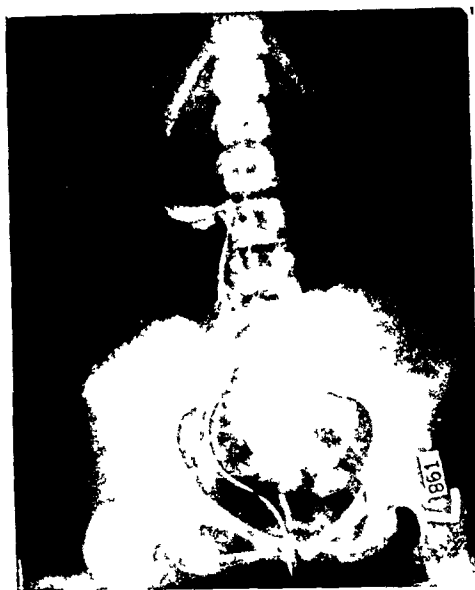


FIG. 18 (Case v). Film taken November 14, 1925. Note jonquil type of pelvis, lower calices not filling. Slightly dilated ureter down to broad ligament region.



FIG. 19 (Case v). Film taken March 10, 1926. Compare with Fig. 18, and note marked change in position after patient had gained in weight. Calices all filled. Blurring of pelvic outline due to movement of patient because of pain caused by removal of bulb through lower stricture areas.

was the only lesion found to account for the hematuria) there were 49 whose history of bleeding was such as to justify a classification under the traditional term of essential hematuria. In order to forestall criticism, however, I have still further restricted the list to 27, as representing those patients whose bleeding was so profuse or so prolonged that the most critical could not deny them the usual classification under idiopathic or essential hematuria.

Space forbidding a detailed report on these cases, I have arranged the following table as a summary of the important data relating to the bleeding, the treatment, and the end-results.

It will be noted that all of these patients had noticed macroscopic bleeding, and in 21 instances the attending physician reported microscopic blood, while in only 22 cases was blood found on admission of the patient. In some of these sufficient ureteral dilatation had already been done to cause a

shows a large number of ureteral dilatations the bleeding ceased after the first or second dilatation, but the patients returned because of other symptoms.

Some patients are entirely relieved of the hematuria and sufficiently relieved of other symptoms by two or three treatments on either side and then cease treatments even though advised that they should persist until a higher dilatation is obtained. A few months later they return because of the reappearance of blood or of some of their former symptoms.

Others persist in bleeding in spite of apparently adequate dilatation until some focus of infection is removed.

In order to present a few urograms of the type of patients under discussion, and to emphasize some of the therapeutic points discussed in this paper, the following condensed case histories are submitted,

their numbers corresponding with those in the preceding table.

CASE I (Figs. 2 and 3), illustrating a case of persistent bleeding, without visible improvement after the first ureteral dilatation. The urogram suggested a filling defect that might have been due to tumor. The hemoglobin continued to decline. Nephrotomy on the nineteenth day of the hematuria.

E. A. (colored), aged twenty-eight, 5 para, youngest three years old. Admitted November 16, 1929, because of macroscopic hematuria. November 10, the patient went to bed at 10 P.M. feeling perfectly well. At 1 A.M. November 11, she was suddenly awakened with an intense knifelike pain in the left kidney region. This pain subsided after an hour of hot compresses. The following morning she voided urine suggesting pure blood, and all voidings in the next five days showed macroscopic blood. Just before each voiding there was a sharp pain in the left lower quadrant which subsided immediately after the bladder was empty.

On admission the temperature was normal, blood pressure 130/80, hemoglobin 50 per cent, white blood corpuscles 4880. The left kidney was not palpable and there was no tenderness in this region. There was tenderness on palpation of the left ureter at the pelvic brim, and greater tenderness on palpation of the ureter in the broad ligament region. Here the ureter could be palpated and felt as if thickened by an edema rather than by tuberculous infiltration. On cystoscopy and after evacuation of a considerable amount of dark bloody urine the bladder mucosa was found to be normal. Bloody urine was seen to be coming from the left ureteral orifice. (No note on the right orifice.) The left side was catheterized with a No. 8 renal open end catheter carrying a 4 mm. (12 Fr.) wax bulb. Urine looking like pure blood was secreted freely. Two x-ray films were taken, the first a flat x-ray showed no evidence of stone, the second, a urogram (Fig. 2) showed a fairly widely dilated abdominal ureter with angled convolutions in its upper portion, a moderately dilated renal pelvis, and calices of fairly clean-cut outline and moderate dilatation. The pelvis showed a dark shadow or filling defect on its median border strongly suggesting a tumor, but which, in view of all the findings, I interpreted as a blood-clot. The upper portion of the pelvic ureter showed slight reflux of the NaI solution beside the catheter, and some of the solution had reached the bladder. The lower half of the pelvic ureter was filled by the catheter. On withdrawal of the catheter

the 4 mm. bulb had a moderate hang at 11 cm. from the external urethra or at about 6 cm. above the ureteral orifice. Slant agar culture from the left kidney urine showed a heavy growth of *Staphylococcus albus*.

The macroscopic bleeding persisted after this first dilatation, and the hemoglobin steadily declined, registering on Nov. 18, 47 per cent, Nov. 21, 39 per cent, Nov. 23, 36 per cent. On Nov. 23, a blood transfusion was given and the hemoglobin registered on Nov. 24, 44 per cent and on Nov. 26, 41 per cent.

I concluded from our tests that the patient had ureteral stricture and I was strongly tempted to try the effects of one more ureteral dilatation, but because of the absence of visible results from the first dilatation, and especially because of the filling defect in the urogram, which suggested a possible tumor of the pelvis I decided to explore the kidney by operation.

On Nov. 30, two weeks after admission, a left exploratory nephrotomy was done. The kidney was found to be of about normal size and was free from adhesions about its lower two-thirds. Its upper third was densely adherent, and the adrenal gland was considerably mutilated in freeing the upper pole. After delivering the kidney we found a depressed scar across its upper anterior face. The pelvis was distended by a soft mass which felt like a blood-clot. The kidney was split from pole to pole by the Brödel incision. After the washing out of the blood-clot careful inspection failed to reveal any point of bleeding. The two halves were apposed by square sutures of plain No. 2 catgut. Pelvic drainage was established by leaving two Dakin tubes.

On Dec. 15, sixteen days after operation, a one-hour intravenous phenolsulphonphthalein test showed a total of 510 c.c. with 70 per cent of the dye, a surprising result especially in view of the later findings on investigation of the right side.

On Dec. 28, examination revealed a stricture in the right ureter symmetrical with that in the left and a kidney pelvis holding 27 c.c. (Fig. 3).

We have been unable to get this patient back for further study and treatment, but on Dec. 7, 1930, we learned from a relative that she has had no further bleeding, and her only complaint is "weakness across the back" when her position in service becomes particularly hard.

CASE VI (Figs. 4 and 5). Mrs. M. E., aged thirty-nine, admitted in January, 1926, presents a particularly interesting history from the viewpoint of focal infection. Her troubles began in December, 1921, when she experi-

enced pain in the left kidney region and macroscopic hematuria which persisted in all voidings for four months. In April, 1922, she entered a hospital for tonsillectomy. Her left kidney pain ceased before she left the hospital, and within two weeks of the tonsillectomy the hematuria ceased. She remained well for three years, and then, for one year before consulting me, the pain in the left kidney region and the hematuria had been about constant. She was said to have had six cystoscopic treatments on the left side between March and August, 1925, and had been advised to have the left kidney removed.

I was much surprised to be unable to get even a fine whalebone filiform to enter the left ureter more than 3 or 4 cm. It was not until my fourth attempt at ten-day intervals that a catheter was carried to the left kidney. Both sides were finally well dilated, the left to a 5.3 mm. (16 Fr.) bulb and the right to a 5.6 mm. (17 Fr.). The left kidney, which had been condemned for removal, yielded a half-hour intravenous phenolsulphonphthalein of 20 per cent against 30 per cent on the right.

A letter from her physician, Dr. S. M. Crisp of Greenville, N. C., on June 4, 1930, states that the patient has had no bleeding since her treatment, and has some pain in the left kidney region only when she stands too long or fails to drink water freely.

CASE XIV, (Figs. 6 and 7). Illustrating a case of only forty-eight hours of severe hematuria.

Mrs. F. M., aged thirty-three years, widow, referred to Dr. Leo Brady Nov. 5, 1929. Menstrual history normal except for an intermenstrual flow of three days' duration, ten days ago. Her regular period now due. Four or five days ago developed a pain in the right flank, radiating into the bladder. Two days ago the urine became bloody and this feature rapidly increased to an appearance of pure blood. On Nov. 6, cystoscopy showed that the blood was coming from the right ureter. Bilateral catheterization was instituted and a urogram was made of the right side. This was a poor film but it showed a filling defect in the right pelvis which was interpreted as due to blood-clot or tumor. There was much pain for the first twenty-four hours, but the bleeding was distinctly less in amount. During the second twenty-four hours the pain returned in the right kidney region and the urine again was like pure blood. During the third twenty-four-hour period the patient ceased voiding and only 30 c.c. of urine were obtained by catheter.

I saw the patient with Dr. Brady at midnight a few hours after she had been given intraven-

ously 500 c.c. of 25 per cent glucose solution and just after she had been given a hot tub followed by a hot pack. At the conclusion of the hot pack and during our consultation she expressed a desire to void and passed 300 c.c. of slightly bloody urine. From that time her recovery was uninterrupted and Dr. Brady later obtained the urograms shown in Figs. 6 and 7. During her period of suppression the patient was mentally sluggish and drowsy and the non protein nitrogen registered 70 mg. At Dr. Brady's request I made the final examinations and ureteral dilatations on Feb. 5 and 8, 1930. The patient had fully recovered and had no symptoms except a slight lumbar backache when working hard and at the menstrual periods. The urine was normal, and the pelviureteral capacity was now 16 c.c. on the right and 11 c.c. on the left.

CASE XVI (Figs. 8 and 9). History on patient's first visit of intermittent bleeding over a period of two years. Persistence of this intermittent bleeding over another period of three years in spite of repeated wide dilatation of strictures in the lower ureters and tonsillectomy. Finally, on review of old urograms (Figs. 6 and 7), we concluded that high strictures might be present. These were found by the bulb test and after another two years of intermittent bleeding and treatments the patient has been free from all symptoms for three years.

Miss McC., aged thirty-six, referred in September, 1922, by Dr. Richard Bell, Staunton, Va. About two years ago, during a bad head cold, the patient noticed what she thought was blood in the urine. This lasted about one week and as there were no other urinary tract symptoms the patient ignored it. About six months ago, while nursing members of the family ill with influenza, she was taken with an attack of what was diagnosed as intestinal influenza. The patient was perfectly well on Sunday night and on Monday morning she awakened with great nausea, a raging headache, severe backache, pains down the legs, and blood in the urine. There was fever only on the first day. These symptoms persisting, she was kept in bed for eight days, when the bleeding and other symptoms ceased. Ten days after she got up hematuria appeared again and disappeared after a week in bed. During this attack bladder symptoms began as pain and soreness referred to the bladder and urethra. Later she began to have much aching and soreness in both sides of the pelvis. Three months ago cystoscopy was done followed in forty-eight hours by severe right renal colic. Since then she is often awakened after three or four hours of



sound sleep by a peculiar heavy feeling in the right kidney region and she can shift her position in bed only with great care. Repeated examinations of the urine during the past four or five months have been negative, and the urine on her admission was normal. Her chief complaints on admission seemed to be referable to the genital rather than to the urinary tract. There occurred intermittently a miserable feeling through the entire lower abdomen, extending from the umbilical region down through the pelvis and into the perineum. There was a bearing-down sensation as if the pelvic organs were about to come out. These symptoms were exaggerated at the menstrual period.

Bilateral stricture was found and two dilatations were given on each side during September and October, and in November a tonsillectomy was performed. She returned in March, 1923, five months later, reporting that there was much less of the old pain low down in the pelvis, but she had developed considerable backache for the first time in her life, when lifting or doing extra work. She gets very tired and is easily played out since her tonsils were removed in November. On this visit she had one treatment on each side with a 5 mm. bulb, and in April another treatment on each side with a 5.6 mm. bulb on the right and a 5.3 mm. on the left.

She returned one year later in March, 1924, saying that she had felt very well for three months after the previous treatments, but that in July, 1923, the hematuria had reappeared. She remained in bed for a time and felt better in September and October than she had at any time for several years. Then in January, 1924, she was overworking and had hematuria again and had had it practically constantly for the three months before coming except when she remained in bed. The left side seems to give more discomfort, there often being a pain through the lower left quadrant which makes her feel that she must keep the left leg flexed. Her most nagging discomfort is a feeling as of a heavy weight in the region of the symphysis. No recent bladder symptoms.

She had 5 treatments on each side from March until June, 1924, the dilatations being carried to a 6 mm. bulb on the right, and a 5.6 mm. on the left.

In March, 1925, Dr. John Neff, of the University of Virginia, wrote me that the patient had consulted him because of a return of her bleeding and because she was living near him and wished to save the expense of the long trip to Baltimore. In reviewing her case for Dr. Neff I got out her x-rays and was

impressed by the comparatively narrow areas in the upper ureters and I wrote Dr. Neff that if he would put his bulbs near the tip of the catheter he might find that she had high strictures as well as the low ones which I had been treating so thoroughly. Dr. Neff found this to be the case and treated her off and on for two years. According to a letter received in October, 1930, she has been entirely well and free from symptoms of any kind for the past three years.

CASE XVIII (Figs. 10 and 11). Mrs. E. O., aged thirty-one, admitted Oct. 4, 1924, because of macroscopic hematuria. Since the birth of her first child seven years ago the patient has never been free from a burning sensation in the bladder which always appears just after voiding and lasts for several minutes. Every October since 1918, or for six years, she has had an attack of hematuria lasting two to three weeks. Each of these seasonal attacks has been accompanied by a sore throat.

The patient was undernourished, and the hemoglobin was only 49 per cent. Her tonsils were small but definitely diseased. The hematuria coming from the right kidney ceased promptly after three dilatations up to a 5.3 mm. (16 Fr.) bulb. The left ureter was dilated once only with a 3.6 mm. (11 Fr.) bulb. The tonsils were removed Nov. 8, 1924.

In May, 1930, our Social Service Department learned from a sister that the patient had left the city and that she was not in good health but the sister thought she had not had further bleeding.

CASE XX (Figs. 12, 13, 14). Mrs. B. R., aged thirty-six, admitted May 1, 1929. Married sixteen years, 6 para, the youngest child being seven years of age. For five years the patient had been having attacks of bladder pain and great frequency. These attacks come on once or twice a month and last from one to two days, but between attacks she is entirely free of symptoms. During the attacks she has to void every two or three minutes, and has severe pain and occasionally has noticed blood in the urine with these attacks. There was considerable microscopic blood in the bladder urine on admission.

Eleven years ago she was operated on for appendicitis and suspension of the uterus. Two years ago she had an operation for an ovarian tumor and perineal repair. Since this her symptoms have been considerably worse.

The right ureteral orifice could not be located but was probably the site of a stricture, which was causing a ballooning of the ureterovesical wall into the bladder. An oblong to cone-shaped, bluish cystic mass projected into the bladder with about a 15 mm. elevation (Fig.

13). The left stricture was located 3 cm. above the ureteral orifice. The ballooning mucosa was opened with the fine-pointed alligator scissors, and while the urograms all show a narrow area in the lower right ureter, in the broad ligament region, just above the ballooning area, yet a 5 mm. bulb showed no hang in this region. On the left side two dilatations were made, up to a 4.6 mm. (14 Fr.) bulb. On her return home in May the patient was advised that she would need to return in the fall for further ureteral dilatations.

A letter from the patient on Oct. 9, 1930, says that she has been considerably improved but that she has had a few of the bladder attacks, not as bad as they were formerly. She has also been having some pain in the kidney regions which she had not noticed before the ureteral treatments. She had not seen any blood in the urine.

CASE XXIII (Fig. 15). Intermittent hematuria for nine months before consultation. Return of hematuria about fifteen months after treatment, but great improvement in general health.

Mrs. M. S., admitted May 1, 1929, aged fifty-five years, 2 para, youngest child twenty-three. The patient has been in ill health for the past twelve years with attacks of pain in the upper left flank and a drawing sensation extending up into the left shoulder and into the back of her neck. At times has severe attacks in the right lower quadrant, a grabbing pain so severe, she has to remain a few moments in a fixed position. With these attacks there is a great frequency of voiding and apparently an increase in the amount of urine. Frequently there is incontinence of urine unassociated with laughing, coughing, sneezing, or any form of physical strain. One of her most disagreeable symptoms is that of a great nervousness or restlessness coming on with the attacks and preventing sleep and impelling her to ceaseless activity even of an aimless character. She says her physicians have never been able to do anything for her relief except to give her hypodermics of morphine. The patient was operated upon six months ago, the diagnosis being a Bartholin's abscess, left; salpingitis, chronic, bilateral; appendicitis, chronic; adhesions about gall bladder. She had consulted another surgeon just before I saw her and had been advised to have a repair of the outlet. She stated that her complaints on admission were the same as those before her operation. She had noticed blood in the urine intermittently for about three months before her operation, and since the operation there had been three severe spells of hematuria, each lasting from four days to a week. Her physician

stated that he had examined the urine about once a week since her operation and always found microscopic blood, and frequently a smoky to red urine macroscopically.

On admission, macroscopically, the urine was bloody and contained albumin (4+), an occasional leucocyte and a bladder culture of *Bacillus coli*. The blood was found to be coming from the right side. Each kidney was the seat of an infected hydronephrosis, slightly less than 1 oz. During May and June, 1929, the ureteral strictures were dilated on either side 3 times up to a 5 mm. (15 Fr.) bulb. The patient returned in September, 1930, and reported better health than she had had for many years. About five weeks previously she had noticed a gradual onset of her highly nervous and agitated state that used to precede the severe attacks of pain in the flanks and the bladder symptoms. A week later a soreness began in the right lower quadrant together with the appearance of blood in the urine. She has noticed blood daily in the past month, and for the past two weeks there has been slight discomfort in both upper flank regions. It was found that the blood was again coming from the right side. Four dilatations, up to a 5.6 mm. (17 Fr.) bulb were given on each side during September and November, 1930, after which, on cessation of all symptoms, the patient was discharged with instructions to return if any should reappear.

CASE XXIV (Fig. 16). Illustrating "essential" hematuria at an advanced age. Miss S., aged seventy-seven years, admitted in October, 1922. Pain in right back fourteen years, often nausea and vomiting with this pain. Bladder symptoms nine years, with passage of brownish material in the urine during the first four years of this period. Microscopic examination during this time showed blood and pus. Blood has been present many times since and was supposed to be due to bladder ulcers. Many x-ray examinations for stone in the kidney and many cystoscopies.

Two years ago, in a neighboring clinic, a diagnosis was made of right ureteral stricture and hydronephrosis of 50 c.c., with microscopic examination of the right kidney urine normal. At that time there was blood in the bladder urine and bloody urine was seen to be coming from the left side. The right ureter was dilated to a No. 10 Fr. but nothing was done on the left side. The urine became clear and the patient was dismissed. She remained comfortable for about a year and then again developed a pain in the right kidney region, irritation of the bladder and bloody urine. She returned to the same clinic where cystoscopy showed a normal bladder. An attempt

to catheterize the right ureter failed and nothing further was done until ten months later when the patient was referred to me.

About one month previously she had had one of her attacks of severe pain in the right kidney region with nausea and vomiting; no fever. She was still complaining of pain and soreness across the back, and urinary frequency. There had recently developed a nagging uneasy feeling in the left lower quadrant "where the ureter enters the bladder." The urine was normal, blood pressure 155/75, a one-hour intravenous differential phenolsulphon phthalein showed:

Right, through catheter, 10 minutes, 20 c.c., 17 per cent

Left, through bladder 4 minutes, 60 c.c., 30 per cent

The right kidney and ureter had a capacity of 50 c.c. The patient improved rapidly under dilatation of her bilateral ureteral strictures, and remained well for four years. She returned in April, 1927, saying that in the fall of 1926 she was having unusual physical activity and again developed a pain in the right hip and flank regions, and later a pain in the right back. These pains have been intermittent and when present there is bladder irritation and frequency. With the onset she sent a specimen of urine to her physician who said it was normal. On readmission we found the catheterized bladder urine normal except for the presence microscopically of many erythrocytes. The two hour subcutaneous phenolsulphon phthalein showed, first hour 30 per cent, second hour 8 per cent. Blood pressure, 160/78. Hemoglobin, 68 per cent.

At the first cystoscopy the following day the urine was normal. The patient remained in the hospital for twenty-three days and both ureters were dilated to a 15 Fr. The right side, which four years previously held 50 c.c., now held 24 c.c. (see Fig. 16).

On sending out the questionnaire in September, 1930, I figured that, if living, the patient would now be eighty-five years of age, and I expected to have a return report by some member of her family. A happy report from the patient says that she is still "going strong" and without urinary tract symptoms.

CASE XXVII (Fig. 17). Illustrating the case of a patient with symptoms for twelve years fairly typical of ureteral stricture. After three weeks of searching investigation on the medical service a diagnosis was reached of "psycho-neurosis." Then the patient was fortunate enough to develop a gross hematuria which led to the true diagnosis of ureteral stricture.

Mrs. M. Y., aged forty-nine years, admitted to the Medical Service March 20, 1930, complaining of a dull aching in the epigastrium, constipation and headache. Twelve years previously the patient had noticed a gradual onset of rather sharp pain in the left upper quadrant and across the epigastrium, accompanied by dull headache, gas with eructation, anorexia, loss of weight and general fatigue. Her pains in the upper abdomen were rather constant and had no relation to meals. She was finally kept in bed for six weeks and a diagnosis was made of visceroptosis. Later she complained of intermittent dull pain in the left lower quadrant, and about the left sacroiliac region. Several years ago she had an attack lasting for several weeks of frequency and burning on micturition. Eighteen months ago she began having blurring of vision and edema about the eyes. She had had the usual diseases of childhood, including occasional attacks of tonsillitis. Four years ago, at the age of forty-five, she began having irregular and profuse menstruation, and was told that she had a tumor of the uterus. Treatment by x-ray was followed promptly by the menopause.

During her first three weeks in the hospital exhaustive studies were made of the various organs and systems with the exception of the urinary tract. In spite of her suggestive history, this omission of the urinary tract was probably based on the traditional notion that a normal urine means a normal urinary tract.

On April 12, three weeks after admission, the patient began complaining of frequency of urination with severe pains in the right thigh and lumbar region, and a catheterized specimen of the bladder urine contained macroscopic blood. On April 13, Dr. TeLinde was asked to see the patient and suggested a complete urological investigation as soon as the patient's acute symptoms subsided. That night the patient had an attack of sharp pain in the left lumbar region without fever, chill or nausea and orders were given to save the urine carefully for investigation for calculus. The urine was stained for tubercle bacilli with negative results, and the culture from the bladder was negative. Macroscopic blood persisted in all voidings for ten days. Then, on April 22, Dr. TeLinde made the first investigation, finding bloody urine coming from the left side, and the left kidney took 18 c.c. of NaI for the urogram. A 4 mm. bulb had a hang at a point 2 to 3 cm. above the bladder (Fig. 17).

The left kidney urine was negative except for the blood.

The half-hour intravenous phenolsulphon phthalein showed:

	Appearance Time	Amount	Per Cent
Left (catheter).....	8 minutes	20 c.c.	10
Right (bladder).....	5 minutes	30 c.c.	25

After the second dilatation on the left side the bleeding ceased entirely. The dilatations were carried up to a 15 Fr. bulb after which the patient was discharged as well.

In spite of the fact that the patient left the hospital most grateful and happy that she had been entirely relieved of symptoms of twelve years' duration, her final diagnosis was headed with "Psychoneurosis," probably as a slight reward for her obstinacy in not yielding positive findings during her first three weeks in the hospital.

The disease under discussion is frequently referred to in the literature as "symptomless unilateral hematuria." That this is an inaccurate description becomes manifest at once to anyone who takes careful histories and closely follows the developments in the individual patient in even a short series of cases. The condition is seldom symptomless, and the patient may present herself today with the hematuria entirely from one kidney, but a month later may return with another attack of hematuria, and examination reveal that the bleeding is from the other kidney, or perhaps from both. It is a well recognized fact that the patient who has undergone a unilateral nephrectomy for a so-called essential hematuria not infrequently returns because of bleeding from the remaining kidney.

In this series of 200 patients, who came complaining of macroscopic hematuria or in whose first catheterized bladder specimen microscopic blood was found, we demonstrated ureteral stricture in 174, as previously described. A careful analysis of the symptoms in this series of 174 cases yields the following table which will be of great significance to anyone familiar with ureteral stricture work.

Two of the 174 cases or 1.7 per cent may be classified as symptomless, these patients having presented the one complaint of macroscopic hematuria.

The tabulated symptoms were as follows:

	Per Cent
1. Pain located definitely in the kidney region.	68
2. Backache, some of these also classified under (1).....	50
3. Pain in the lower pelvis (ureteral ?) .....	51
4. Dysmenorrhea.....	20
5. Pain in the hip.....	10
6. Pain extending down the thigh.....	17

	Per Cent
7. Pain referred to the perineum.....	6
8. Dyspareunia.....	5
9. Headache.....	34
10. Gastrointestinal symptoms.....	39
11. Fever, including the pyelitis cases.....	29
12. Bladder symptoms.....	84

Most patients who come because of ureteral stricture complain of at least two or three of the symptoms listed here, and in carefully obtained histories one finds that not a few patients with stricture cover practically the entire list.

The best evidence that such an array of symptoms may be dependent on the presence of stricture, and consequent urinary stasis, is the satisfactory proportion of patients who cease complaining of these symptoms after adequate ureteral drainage has been established.

Having a working familiarity with the various methods advocated in the past thirty years for the cure of the condition known as essential hematuria, I have no hesitation in stating that we have never before been able to make such a record as is presented in this table. With a list of 27 patients chosen from 99 of a similar character, because of the extreme degree or long duration of their bleeding, we find, (1) that only 3 of the patients were submitted to kidney operations: Case I, a left nephrotomy after one ureteral dilatation and the persistence of threatening hematuria; Case II, a left nephrectomy (a year after the bleeding had ceased) because we had determined that the left kidney was functionless, but still continued to cause pain; and Case XIII, in which, before admission, the patient had been submitted to a bilateral kidney fixation without apparent influence on her bleeding.

In our hands only 1 of the 27 patients (Case I) underwent a kidney operation because of bleeding.

Three of the 27 patients have had what we consider poor results: Case xv, a colored woman, who had but 3 dilatations on each side and then ceased treatments before we had an opportunity to refer her to other departments for investigation for possible foci of infection; Case xvii, a nurse, who ceased bleeding for two years after ureteral dilatations, but has

had intermittent bleeding again for the past four years. She lives at a distance and has had some treatments in the past four years, but we do not know how thorough these have been; Case XIX, a colored woman who had two treatments on the most painful side and then decided she could not stand more treatments.

Case XXII, a sixty-five year old patient died of diphtheria one year after beginning treatments, was still having microscopic bleeding, but her improvement in general health after many years of invalidism was most satisfactory in spite of the unusual density of her strictures which had permitted of a dilatation to only 4 mm., 12 Fr., with 14 dilatations on the right, and to only 3.6 mm. (11 Fr.) with 13 dilatations on the left.

Case VII might be eliminated as an ideal result because the patient continued to bleed until the end of her pregnancy after being dilated to a 15 Fr. when she was four to five months pregnant. Since delivery she has had four months without bleeding although her chief attacks of hematuria in the past four years have followed immediately after each of three childbirths.

Case V might also be eliminated as an ideal result, for after treatments in 1925 and 1926, resulting in a cessation of bleeding for four years, the patient returned in July, 1930, with hematuria, and a tuberculous right kidney was found. During her intermittent treatments in 1925 to 1926, there had been no bladder symptoms, and cystoscopy had always revealed a normal bladder and normal ureteral orifices. In spite of the fact that we never found leucocytes in the urine our routine investigations during this time record on Nov. 11, 1925 a slide for examination for tubercle bacilli as negative, as well as guinea-pig inoculations from the bladder urine in April, 1926, and from the right kidney urine in December, 1926, as negative. The chest examination and x-rays in November, 1925 resulted in a diagnosis of "slight infiltration of both sides—tuberculosis."

From these facts and because of improvement in general health and absence of hematuria for four years after our ureteral treatments I think the tuberculosis of the right kidney was a later development probably favored by the stasis due to ureteral stricture. Figures 18 and 19 show a remarkable change in the position of the right kidney within four months. The patient had 3 dilatations of the right side, up to a 5 mm., 15 Fr., bulb on Nov. 3, 14, and Dec. 8, 1925. She ceased bleeding, gained in general health, and increased in weight, but returned in March, 1926, because of reappearance of the bleeding. After 3 dilatations in March and April she did not bleed again until

November, 1926. After two dilatations she did not see blood again for nearly four years when she returned in July, 1930, with hematuria, severe bladder symptoms, and a much ulcerated bladder. Tuberculosis of the right kidney was demonstrated.

Excluding 9 cases in which the results were not ideal (although ureteral treatments were of distinct value in most of them) we record 18 patients in the preceding table or 66.6 per cent who obtained what we may term ideal results from no other treatment than ureteral dilatations and attention to focal infections. Of course some of these may return at some future time with further bleeding and in need of more dilatations, and some may return having developed a kidney infection, a neoplasm, calculus, or tuberculosis; but the treatment given to these patients would render the occurrence of such incidences (except for a neoplasm) far less likely, and such recurrences would not detract from the value of the methods advocated.

#### CONCLUSIONS

1. The preceding analysis of 200 cases of hematuria seems to indicate that ureteral stricture is the most frequent cause of renal bleeding, and that stricture, together with its frequent background of focal infection, accounts for practically all those cases formerly diagnosed as idiopathic or essential hematuria.

2. It may seriously be questioned whether these terms are of further practical value in our diagnostic work, and whether they should not be discarded because their use tends to promote loose thinking, inaccurate observation, and erroneous therapeutics.

3. We believe that ureteral stricture is one of the most important factors in the development of hydronephrosis, renal infections, renal and ureteral calculus, and renal tuberculosis; and we know from experience that the lesion is of such common occurrence that it is sometimes found in association with neoplasm. We may

therefore sound the important warning that the finding of ureteral stricture in association with renal bleeding does not for a moment relieve the diagnostician from the responsibility of further exhaustive studies to determine whether stricture and a distant focal infection area are the only factors responsible for the hematuria, and especially to determine at the earliest time possible whether neoplasm is developing in the upper urinary tract.

DR. OSWALD S. LOWSLEY: I have been familiar with the intensive work of Dr. Hunner since 1910 when I was a student in Baltimore and heard his first talks; and now after this last thorough presentation I feel that he has certainly "put it over." Today there are very few people who will not admit that there is such a thing as stricture of the ureter. For some years it was questioned as to whether it ever occurs; but I was convinced early and firmly believe that it is a very important matter to be considered: in fact, I developed one myself, and was relieved by dilatation.

The matter of painless hematuria is one of the most fascinating questions in urology, and when a patient presents himself or herself with that sort of history the urologist is often taxed to the uttermost to determine the cause; but the fact that stricture does play so important a part in the condition has just been shown so clearly that I need not discuss that point. I would, however, like to say a few words concerning 2 cases that have come under my observation that were most interesting and somewhat baffling.

The first patient presented himself with a history of painless hematuria on three occasions. On the first two of these occasions he was examined thoroughly by me, but we found no apparent cause for the bleeding; he had no infection of the kidney; no bacteria grew from culture, and the pyelogram showed nothing. We then did bilateral pyelograms; the more baffling the case, the more interesting it became. Each time that the patient came his history was studied thoroughly; but finally, when reviewing the situation on the third occasion we learned that the painless hematuria had followed an attack of Coryza during which the patient had been confined to his home. We are all aware of the fact that the urinary tract is irritated by any infection anywhere, so we were considerably baffled by the fact that we did not get bacteria from the urine. Then we went into the question of treatment: Each time he had a cold, he took salol and

went to bed. After learning that, we persuaded him not to take salol, and since then he has never had any signs of hematuria. That is one point that I wished to mention.

We all know that bladder irritation shows various symptoms, and we see them in cases of stricture frequently without bacteria or pus in the urine. We also see lesions of the bladder without bacteria; but there is another type of case which simulates this, too, and for which the urologist must be on his guard. I firmly believe that there is a trophic bladder condition occurring chiefly in women, especially those who have either passed the menopause or else had an artificial menopause; in these cases the symptoms are relieved not by local treatment, but by the administration of some of the glands of internal secretion.

DR. N. P. RATHBUN: Both idiopathic hematuria and stricture of the ureter are very large subjects, which leave room for almost endless discussion. Dr. Hunner's explanation of why stricture of the ureter would account for bleeding and connecting it up with the work done by Ilinman, Lee-Brown and others is very plausible. Years ago we used to speak of idiopathic hematuria as an end diagnosis, knowing at the time that it was really an incomplete diagnosis. In the earlier days we were satisfied with a 15 per cent margin. That has gradually narrowed down to 5 per cent or less and Dr. Hunner's work may well narrow it still further. Many cases of course prove after careful study to be cases of early tumor, early tuberculosis or stone not opaque to the x-ray. These will often be determined by a later examination. I was glad to hear Dr. Hunner emphasize the point that many of these cases that bleed sometimes present also pain as a symptom. I have also noted this. He also stresses the point of their usually being bilateral. I have no doubt this is true in many cases but I have followed some over long periods of time, which apparently were unilateral. There is another factor which I have noted in some of these cases of obscure bleeding and which I reported in a paper some years ago. We have all attempted at times to explore these kidneys, doing various things such as decapsulation, nephrotomy, etc. In 2 of the patients upon whom I performed a nephrotomy I was obliged a few days later to do a nephrectomy for secondary severe bleeding. Careful study of the kidneys removed showed them to contain numerous areas of what I interpreted as old scars, which represented acute infections perhaps many years before. Of course we all know that many severe cortical infections of the kidney get well spontaneously and that abscesses may rupture

in the calices or tubules and it is reasonable to believe that these cases leave scars which may be a factor in producing symptoms of hemorrhage and pain in later years. I quite agree with Dr. Hunner about the importance of checking up on focal infections in all of these cases. I have enjoyed these pictures and this presentation and think that the most important point of Dr. Hunner's contribution lies in his clinical reports and his results. Many persons may doubt many of his theories about strictures in the ureter and there are perhaps relatively few people who go all the way with him in his attitude toward this subject, though we cannot doubt his veracity and he certainly presents many cases with clear clinical histories and cures maintained over a long period of years. In other words, he delivers the goods.

DR. A. R. STEVENS: *The very fact that there has been so much difference of opinion regarding the frequency of strictures the writer has added stimulus to our work and has caused us to study our cases more intensively.*

Six or eight years ago I published a paper calling attention to a certain group of cases which appeared early to fall into the category of so-called idiopathic hematuria. These cases were investigated, but no cause for the painless hematuria was found. After periods varying from four months to fifteen years, the mysteries were solved by the establishment of usual diagnoses: tuberculosis, stone, tumor. I am sure Dr. Hunner will not object to our placing a little stress on that point, that even though a painless hematuria may yield after some simple procedure, it is wise to keep such patients under observation, and to bear in mind the possibility of that case ultimately coming into one of the ordinary groups of pathological lesions which cause bleeding. In my own work I have come across a group of individuals who have had painless hematuria and in whom I have found stricture. I cannot put my finger on any particular record indicating that the bleeding has stopped after the passage of bougies.

The very plausible explanation of how stricture operates as a factor in producing hematuria is interesting. It seemed hardly plausible that blood came from the strictured area itself. I was impressed by Dr. Hunner's statement that he has stopped irrigation of the renal pelvis in stricture cases. It has always seemed to me that dilatation was the important factor. Also, I think that in many of the reports we have had in the past of painless hematuria having been stopped after the passage of a catheter and perhaps one irrigation of the kidney pelvis, emphasis has been wrongly

placed on the irrigating fluid (adrenalin or silver nitrate). If Dr. Hunner's deductions are correct, the passage of the ureteral catheter should have been given greater credit in these reports.

DR. HOWARD S. JECK: I think Dr. Rathbun's remarks about Dr. Hunner's "delivering the goods" should be emphasized. I know of two women, whose symptoms puzzled several good men, before they finally reached Dr. Hunner. He found definite evidence of ureteral stricture in both patients and both were very definitely relieved.

I think Dr. Hunner's work probably explains many of the mistaken diagnoses which occurred particularly in the early days of pyelography. Not infrequently a kidney, removed because of the diagnosis of renal tumor, proved to be normal. Such diagnoses were often based partly on a pyelogram suggesting tumor but largely on the predominant symptom of painless hematuria.

Recently I had a case that emphasized to me more than any other the possibility that hematuria may be a symptom of ureteral stricture. A man came to me with every evidence of stone, typical attacks of colic and hematuria. I had some very careful x-ray pictures made and no shadows suggesting stones were observed. A urogram showed one of the most definite ureteral strictures I have ever seen. From the vesical orifice upwards for at least 2 in. there was simply a thread of shadow representing the lumen of the ureter. Above the stricture the ureter was dilated. The passage of the catheter incident to making the urogram gave the patient complete relief.

DR. T. J. KIRWIN: I am sure that the younger members of the Urological Section have been very glad to hear Dr. Hunner's paper. I regret that what is known in Europe as "the American disease" has now become an actual disease in France, Germany, and England.

DR. GUY L. HUNNER (*closing*): Some fifteen years ago I was bold enough to read before the Urological Society my first paper on ureteral stricture. The discussion that night did not seem quite fair to some of your members, for they came to me after the meeting with apologies, and asserted that the members assailing my views did not mean to suggest that I did not know what I was talking about, nor did they mean to class me with Ananias; but for any man to state that he had seen 50 cases of any disease as rare as ureteral stricture was rather more than they could swallow.

I assured them that I had not taken the numerous frank opinions as an insult, and told them that my results on my patients had been such that I felt certain they would find



stricture as often as I if they simply looked for it. It is naturally more agreeable to be met as I have been tonight with a large percentage of agreement and a little disagreement. But it is only by disagreement and viewing a problem from all angles that we finally arrive at the truth.

Dr. Lowsley's loyalty in presenting himself as a stricture victim is beyond measure. He brings up the case of the man with a bad cold and with urinary tract symptoms and a hematuria. Further investigation showed that the hematuria was probably due to his medication. Dr. Lowsley expressed his surprise that the urine did not show infection. But this is almost characteristic in these cases of urinary tract inflammations secondary to focal infections, be the inflammation located in the urethra, trigonum, or ureter. The symptoms may be quite aggravated but the urine is negative or only slightly altered, and does not show an infection. If the kidney has derived a stasis we may find infection in the urine, but this is usually secondary and by the colon bacillus rather than by the streptococcus or staphylococcus, the probable original invaders of the urinary tract tissues from the distant focus of infection.

The same idea probably applies to Dr. Rathbun's cases, the two kidneys which he was obliged to remove because of severe persistent bleeding without evident cause, and in which he found old scars in the kidneys. These scars probably represented direct injury to the kidney tissues by past focal infections. The kidneys may have been invaded directly by the cocci of the focal infection or by their toxins, but it is quite possible that the urinary stream never had more than a temporary invasion of the cocci, and by the time the patient comes with the scars and the bleeding the urine is negative to culture.

Another class of cases of which I am not certain that I have seen a good example, but which I think we should bear in mind when looking for obscure causes of urinary tract irritation, are those described by W. W. Duke of Kansas City as due to anaphylaxis from foods, which produce toxins in certain individuals.

Dr. Rathbun said he had not found many cases with bilateral kidney bleeding. You all know that many authors have written about "unilateral symptomless hematuria," but this is not a good descriptive phrase for these cases as a class. A careful history will reveal in most of them at least slight kidney or ureteral discomforts, or slight bladder symptoms, and while many of them are bleeding from one side only when they are first examined, you often find when the

patients come at subsequent visits that they are bleeding only from the opposite side, or perhaps from both sides at the same time.

Dr. Stevens properly laid stress on those patients in whom you find nothing to account for the bleeding when they first come, but perhaps months or years later you find they have stone or tuberculosis. Did they have the stone or tuberculosis at the time of your first examination? Some of them probably did, but no doubt some of them had only ureteral stricture which you did not have in mind, and consequently overlooked in your first examination, and the stasis from the stricture may have been the chief factor in the subsequent development of stone or tuberculosis.

I have tried to show you that we are dealing with a large family group of pathological processes in the kidney such as stone, tuberculosis, hydronephrosis, chronic pyelitis, and renal hematuria, all of which revert back with a strong inheritance to the parentage of that one simple lesion, stricture of the ureter. I have had a number of patients develop stone in the ureter while being treated for stricture. A little too much trauma in the stricture area may result in bleeding, temporary ulcer, and increased blockage, ideal conditions for the accumulation of urinary salts, and I have seen a fairly large calculus deposit in a stricture area two weeks after the last dilatation.

Dr. Stevens mentioned that some of these patients ceased their bleeding after the passage of one plain catheter and wonders whether the good results, which have often been ascribed to the silver nitrate or the adrenalin used to lavage the kidney in such cases, were not really due to the improvement in drainage following the use of the catheter. Undoubtedly he is correct.

We have all had similar experiences with the patient who comes in with a pain in the kidney. We investigate with a plain catheter without bulb and find a kidney of about normal pelvic capacity. X-rays are read as negative, and the urine is normal, and we assure the patient there is nothing wrong with the urinary tract. The patient comes back a few weeks later and says he experienced a terrible reaction for a few hours after the investigation, and made up his mind that he would never undergo another similar examination. After a few days, however, his kidney pain was gone, but now for a week or two past it has returned; so he has come in to see whether we will not investigate again, for the first examination certainly resulted in great temporary relief. What better evidence do we need to conclude that the patient had a condition of back pressure in the kidney which



the passage of a plain catheter relieved temporarily?

Dr. Jeck spoke of the man with a typical stone history in whom no evidence of stone could be found. There is not a man in this room or in the world who can differentiate from the patient's history whether the symptoms are due to stone or stricture. Either of these conditions may result in the classical symptoms of colic, bladder and rectal tenesmus, and hematuria, and it is only by accurate urological methods of investigation that we make a diagnosis.

There are many cases on record of patients suffering from kidney colics for many years before a stone was passed or made its way down the ureter to a position where it was found near the bladder. I think Hugh Young recorded one such patient who took twenty-six years to deliver his stone from the kidney to the lower ureter. As a matter of fact, the man had probably been suffering many years from ureteral stricture, and his stone may have formed in the stricture area twenty-six years or only twenty-six weeks or even twenty-six days previously.

#### REFERENCES

1. ISRAEL, J. *Chirurgische Klinik der Nierenkrankheiten*. Berl., Hirschwald, 1901, Chap. XIII.
2. STRAUSS, H. Congestive pain and congestive hemorrhage of the kidneys. *Berl. klin. Wchnschr.*, 55: 97, 1918.
3. HUNNER, G. L. Ureteral stricture, an important etiological factor in the so-called essential hematurias. *J. A. M. A.*, 79: 1731, 1922.
4. HINMAN, F., and LEE-BROWN, R. K. Pyelovenous backflow, its relation to pelvic reabsorption, to hydronephrosis and to accidents of pyelography. *J. A. M. A.*, 82: 607, 1924.
5. TRAUT, H. F. The mechanism of pyelovenous backflow. *Surg., Gynec. Obst.*, 48: 662, 1929.
6. KOTZENBERG. *Ztschr. f. Urol.*, 2: 125, 1908.
7. KUMMEL. *Med. Klin.*, No. 35, p. 917, 1916.
8. BUMPUS, H. C., JR. Essential hematuria: a clinical study. *J. A. M. A.*, 90: 593, 1928.
9. LIVERMORE, G. R. Causes of renal bleeding. *J. A. M. A.*, 83: 1390, 1924.



# GUNSHOT WOUNDS OF THE URINARY BLADDER

## REPORT OF TWO CASES\*

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NEW YORK

THESE cases are reported as they are quite unusual in civil practice and demonstrate the value of roentgeno-

grams with sodium iodide injection in such cases.

to void and when catheterized 10 oz. of very bloody urine were obtained.

Examination revealed a moderately obese

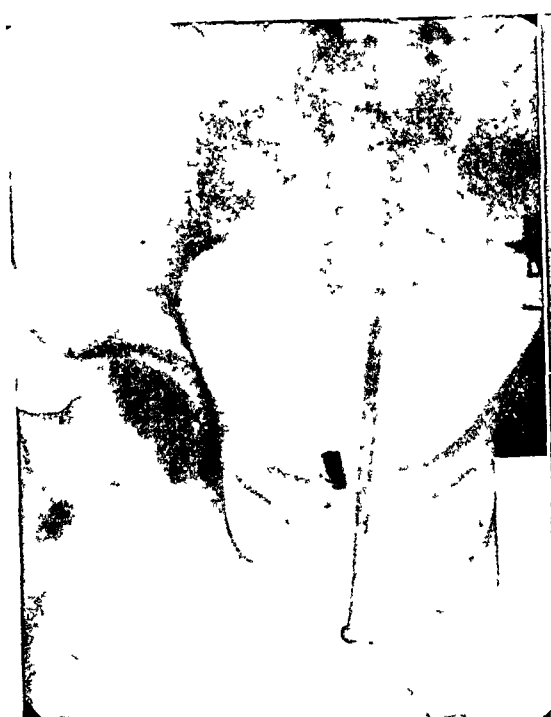


FIG. 1. Case 11, with catheter in place in bladder.

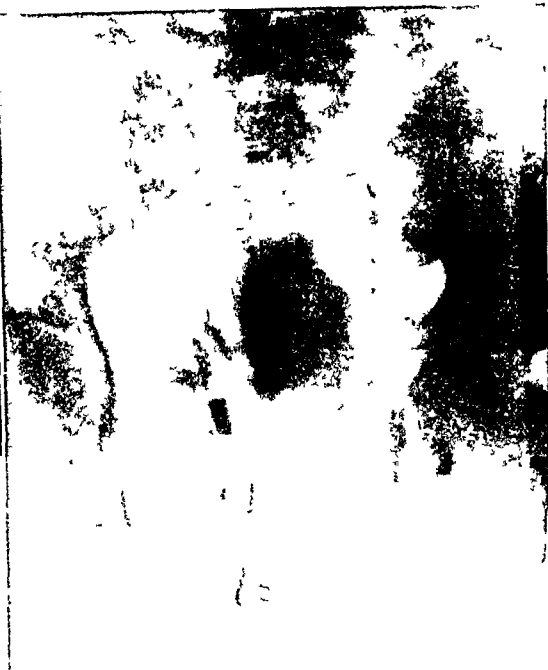


FIG. 2. Same after injection of sodium iodide solution into bladder. Note solution outside bladder and depression in bladder wall caused by hemorrhage and extravasated urine.

grams with sodium iodide injection in such cases.

### CASE REPORTS

CASE 1. T. C., a bartender, aged forty-one years, was admitted to Knickerbocker Hospital December 31, 1930, because of a gunshot wound in the right side. Two hours before admission he had been involved in a holdup and shot with a 44 caliber automatic steel-jacketed bullet.

The wound of entrance was just below the right anterior superior iliac spine. The bullet could be felt just beneath the skin below the left anterior superior iliac spine. He was unable

white man in shock. There was acute tenderness to pressure above the pubis. He was moderately distended although he had had no nausea or vomiting.

Operation was done immediately through a suprapubic midline incision. Two perforations were found in the posterior wall of the bladder just above the entrances of the ureters. Corresponding to these holes were two large holes in the peritoneum. The peritoneal cavity contained a large amount of blood and urine. No bile, gas or other evidence of intestinal perforation could be found.

\* From the Surgical Services of Knickerbocker and St. Luke's Hospitals, New York. Submitted for publication April 12, 1931.

The holes in the bladder were closed from the exterior surface. The holes in the peritoneum were likewise closed. A drain was

tip of the coccyx showed a small puncture wound.

Roentgenograms showed a bullet just above

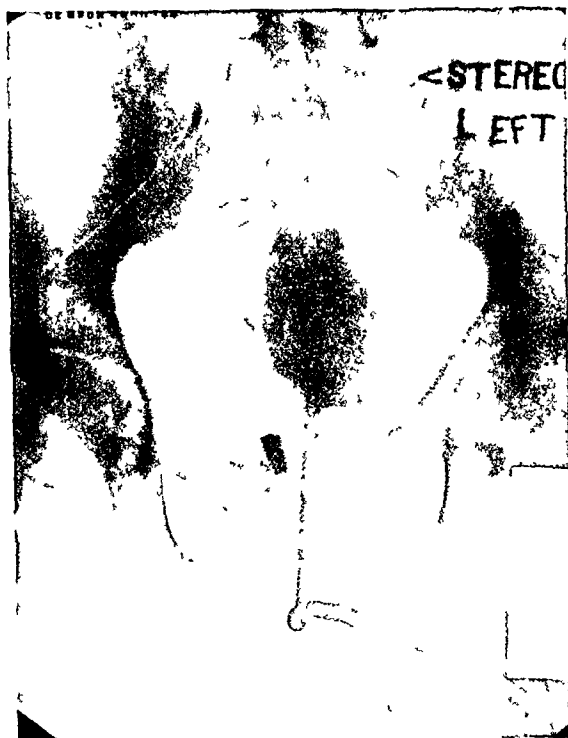


FIG. 3. One-half hour after Figure 2 No sodium iodide is in evidence in peritoneal cavity and bladder contains larger amount of fluid.

placed down behind the bladder extraperitoneally and the peritoneal cavity was drained at the upper end of the incision.

A few hours postoperative the patient developed delirium tremens and notwithstanding a transfusion of 1000 c.c. of whole blood and the administration of whiskey and sedatives he died thirty-six hours after the operation.

**CASE II.** R. V., a student, aged twenty-one years, was admitted to St. Luke's Hospital, January 1, 1931, because of a bullet wound in the right buttock. He had been shot from behind with a 22 caliber rifle. The bullet was bronze or copper jacketed.

Upon admission he stated that he felt like voiding but was unable to do so. Catheterization obtained several ounces of very bloody urine. He did not appear acutely ill. His respirations were 24, pulse 112 and temperature 100°F. The lower abdomen was moderately tender. The right buttock just lateral to the

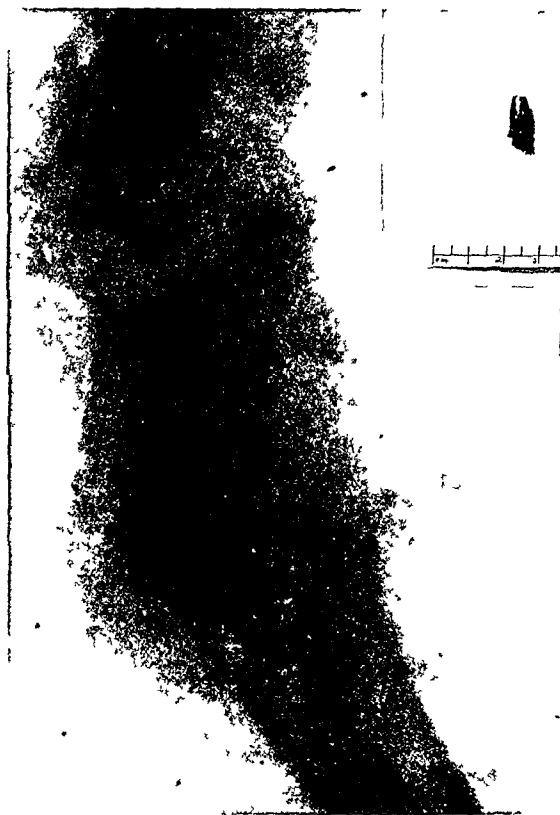


FIG. 4. Lateral view of Case II, showing bullet in rectus muscle just above pubis.

the pubis. Injection of the bladder with sodium iodide demonstrated the presence of a perforation on the right side of the bladder. The sodium iodide did not appear to diffuse into the peritoneal cavity.

Operation was done with ether anesthesia. The bullet was removed from the right rectus muscle just above its attachment to the pubis. The bladder wall was exposed and found to have a slit about 2 in. long in its anterolateral aspect. To the right of and behind the bladder the paravesical tissues were badly torn.

The bleeding points were ligated as far back along the track of the bullet as was readily possible. To control the remaining hemorrhage, this part of the wound was packed with iodoform gauze. The hole in the bladder was closed with three rows of chromic sutures and a soft rubber dam drain placed down beside the packing.

Shortly after the operation large amounts of fairly clear urine drained through the urethral catheter and drainage from the wound was very small in amount. The drains and packing were entirely removed by the fifth day and the retention catheter on the eighth.

Further convalescence was uneventful. He has continued to void normally and has had no symptoms of any kind since.

#### DISCUSSION

It is possible that in the first case there may have been an unsuspected perforation of the intestine although drainage about the rubber dam placed into the peritoneal cavity was only serosanguineous.

The course of the bullet in this case is quite interesting. Starting downward and toward the midline the bullet passed into the peritoneal cavity. The bladder must have been full so that it projected well into the abdominal cavity, and as a result the bullet passed from the peritoneal cavity into the bladder and out again into the

peritoneal cavity, through the peritoneum again, striking the pelvic bone, and from there was deflected upward emerging at a point corresponding to the point of entrance on the opposite side.

The path of the bullet in the second case, had it gone in a straight line from the point of entrance to its position above the pubis, would have been through the peritoneal cavity in the pelvis. Instead of that it followed around the wall of the pelvis striking some bony prominence which deflected the bullet upward and medially. It cut the wall of the bladder and struck just behind the pubis from where it glanced upward into the right rectus muscle. The path was in all probability extraperitoneal throughout its entire course.

That the back end of the bullet struck the pubis can be seen by the fact that fragments of lead were left there and only the back of the bullet was not bronze coated.



# CAN BENIGN THYROID TUMORS METASTASIZE?

## REVIEW OF THE LITERATURE WITH ILLUSTRATIVE CASE REPORT\*

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**T**HE power of metastasizing at a distance has generally been considered as characteristic of primary malignant

general rule of non-metastasization of benign epithelial tumors. Cases of common hyperplastic colloid goiters, giving rise to

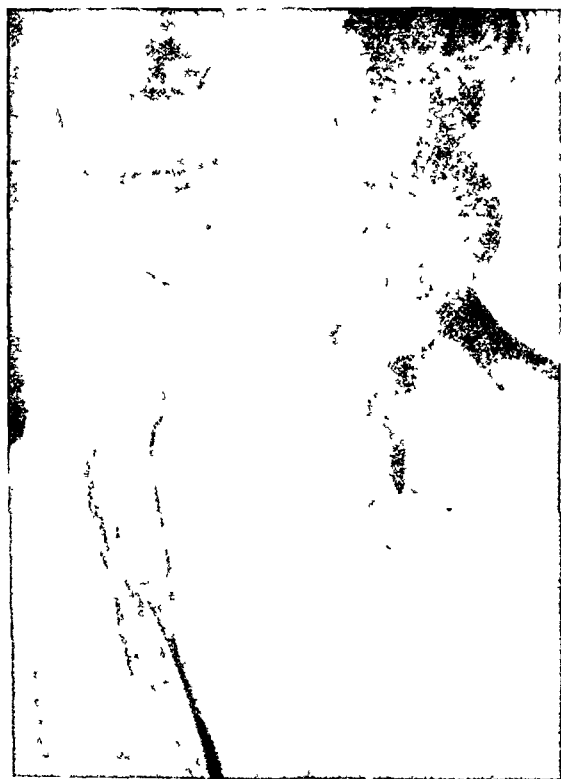


FIG. 1. Appearance of patient nineteen years after first operation for tumor of the neck.

tumors. Nevertheless, certain primary benign connective tissue tumors, such as lipomas, myxomas and chondromas, as well as myeloid tumors, are capable of becoming generalized. Benign epithelial tumors rarely generalize, although when one considers the matter, there does not appear to be any sufficiently adequate reason why they should not do so.

Primary adenomas of the thyroid gland apparently form an exception to the



FIG. 2. Structure of thyroid adenoma. Magnified eighty times.

either benign or malignant metastases in bones, lungs or other tissues are known, although the goiter itself had apparently not undergone any structural change. Indeed, metastatic tumors of pure thyroid tissue structure have been found without any clinical evidence of a primary hyperplasia of the thyroid gland. This fact has given rise to much discussion and controversy and, perhaps, it may be due to the circumstance, as explained by Bérard,<sup>1</sup> that the thyroid more than any other organ, owing to the facility with which

\* Submitted for publication June 29, 1931.

one can transplant it and the close relationship of its secretory elements and its blood and lymph channels, is capable of colonizing in other parts of the body.

Cohnheim<sup>2</sup> in 1876, was the first to draw attention to benign metastasizing thyroid tumors. Cohnheim's patient was a woman aged thirty-five, who came to the hospital on account of an abscess in the left sacro-iliac region. No pus was found on opening it, but in the bottom of the cavity there was necrotic bone which, on histologic examination, showed the typical structure of simple thyroid alveoli containing colloid. Necropsy on this patient showed a moderate enlargement of the thyroid which had been overlooked during life but no penetration of the capsule by any new growth, nor any invasion of neighboring tissues. There were two small adenomas in the interior of the thyroid. Metastatic nodules were found in the lungs and bronchial lymph nodes, in the lumbar vertebrae, the sacral and iliac bones, all showing the histologic structure of simple colloid goiter. From this case it was evident that multiple metastatic bone disease may occur from a small simple thyroid adenoma not giving rise to clinical symptoms.

Patel<sup>3</sup> in 1904, collected 18 cases of histologically benign thyroid tumors giving rise to metastases, some of these metastases being benign and some malignant; however, among those classed as malignant were 3 cases of von Eiselberg who, as we shall see later, regarded all such metastases as essentially malignant even if not histologically proved to be so. Bloodgood<sup>4</sup> in 1906, reported that among 25 adenomas of the thyroid, treated at the Johns Hopkins Hospital since 1899, one was seen with metastases to the neck. Wilkens and Hedren<sup>5</sup> in 1909, reported the case of a patient aged seventy-two, with thyroid adenoma and metastases in the cranial and vertebral bones as well as in the iliopsoas muscles. He questions if these metastases were not sarcomatous. Beilby<sup>6</sup> reported that there were in the literature records of about 20 cases of tumors, ap-

parently metastases from the thyroid, which were histologically benign and some of which were considered metastases from normal thyroid tissue. Where a thyroid lesion had been observed it was a simple hypertrophy or adenoma and the metastatic tumor had a similar histologic structure. However, Wegelin<sup>7</sup> in 1926, accepted only 14 of the cases reported in the literature as being histologically proved benign metastases from benign goiters.

From the more recent literature I will cite only the case of Hinterstoisser.<sup>8</sup> His patient, a woman aged forty-six, had a goiter on the right side extirpated to the fullest extent by von Eiselberg because he considered it malignant. She later developed a goiter on the left side for which a partial thyroidectomy was done, and which was proved histologically to be benign. At the age of sixty-eight, she came to the hospital again and was operated upon for a bone tumor of the left thigh, which was histologically shown to be composed of adenomatous thyroid tissue.

Ginsburg<sup>9</sup> who deals only with the bone metastases of thyroid tumors, has scanned the literature of the subject very thoroughly. He cites a number of cases in support of the contention that such bone metastases are of frequent occurrence not only in carcinoma and sarcoma but also in simple adenoma of the thyroid gland; that bulky metastases may arise from even small thyroid adenomas in any stage of development and that even a malignant metastatic tumor may arise from a benign primary adenoma of the thyroid. The metastatic tumor may increase progressively in size while the primary tumor may at the same time recede.

Before considering the clinical aspects of these metastatic lesions a few words may be said in regard to the pathogenic theories and the controversies that have arisen regarding them.

Cohnheim, in accounting for the metastases in his case, considered that the elements of the tumor accidentally penetrated the lymph and blood vessels.

Patel remarks that the colloid goiter is especially that which gives rise to metastases; it is the one which is remarkable

such primary metastasizing tumors as malignant and gives them the name of adenocarcinoma, even though no true



FIG. 3. Chest of patient with metastasizing benign adenoma of thyroid nineteen years after onset of disease.

for its diffuse cellular proliferation; the cells pass into the capillary circulation, arrive at their destination and develop independently on their own accord either silently, benignly or malignantly.

Wolfer<sup>10</sup> whose work on the histogenesis of goiter and thyroid tumors is classic, developed the theory that the thyroid adenoma was only the survival of a fetal adenoma and was a veritable thyroid cancer. He held the view that the goiter which gives origin to metastases ought not to be considered a benign tumor and that the metastatic tumors arising from it, even though histologically not malignant, should be considered as clinically so on account of their growth and destructive action. Von Eiselberg<sup>11</sup> and others also insisted that the occurrence of metastases is proof of essential malignancy, an opinion with which Zadek<sup>12</sup> concurs. He classifies all



FIG. 4. Patient six months after last operation.

carcinomatous tissue can be found. If not biologically, they are clinically malignant. In Adolf Meyer's<sup>13</sup> case the primary thyroid tumor while adenomatous in one part was apparently undergoing adenocarcinosis in another part, the metastases were benign in some places and adenocarcinomatous in others, the development apparently depending upon the soil in which the cells found themselves.

Ewing considers that metastatic tumors of thyroid tissue may arise from aberrant normal thyroid cells. In connection with them the question of aberrant parathyroid cells may also be mentioned apropos a case reported by Kraft,<sup>14</sup> in which the necropsy on a woman aged sixty, showed a tumor of the left thyroid lobe with metastases in

both lungs and in the pleura and skull, which histologically showed the structure of Langhan's parastruma (parathyroid). The author says that such structures are often found in the thyroid and classed as adenoma.

Another point that might be mentioned here is that the site of a traumatism might act as a *locus minoris resistentiae* in which a metastatic thyroid tumor may appear, as in Brinkmann's<sup>15</sup> case, in which a woman aged forty-five, with no clinically demonstrable thyroid tumor, presented a thyroid tissue tumor at the site of a traumatism in the thigh.

Shapiro<sup>16</sup> in a report recently published, offers a new theory in connection with these cases. In his case there was a benign nodose struma colli with numerous goitrous nodules scattered in the omentum and on the intestinal serosa; ectopic thyroid tissue was also found in the ovary. Shapiro believes that the goitrous nodules in the omentum as well as those in the peritoneal linings, had arisen, not directly from the struma colli, nor as embryonary displacements of thyroid anlage, but as late secondary metastases from the ectopic benign thyroid tissue in the ovary. This would be in accord with Ewing's assertion that metastatic thyroid tissue tumors may arise from aberrant normal thyroid cells.

#### CLINICAL ASPECTS

From the clinical aspect, metastases from primary benign thyroid tumors are more frequently observed in females than in males. This is probably accounted for by the greater incidence of goiter in the female sex. Of Patel's 18 cases 14 were in females. Zadek gives two-thirds of 60 thyroid metastatic bone tumors as occurring in women; 90 per cent of these are between the ages of thirty and seventy years.

The great tendency is toward bone metastases, the short and flat bones especially being invaded. According to Zadek, 38 per cent of the bone metastases occur in

the cranium and 16 per cent in the vertebrae.

Very frequently, owing to the absence of symptoms from the thyroid, the bone metastases are diagnosed as primary sarcoma. From the clinical standpoint the matter would often be of little import, as the tumors have a destructive growth tendency, but in cases where amputation is considered it would be well to investigate the thyroid. It often is apparently quite normal even with extensive metastases, and in any case it is assumed that a histologic biopsy would be made before deciding upon such an important step. If suspected malignancy is not verified an unnecessary amputation might be avoided.

Thyroid metastatic tumors are often sluggish in symptomatology. Such bone tumors do not offer symptoms different from those of other bone tumors. Spinal column metastases may give rise to symptoms of hemiplegia or paraplegia, due either to compression, invasion of the cord tissues or deformity of the column by the growth.

Metastases to the lungs and viscera are much less frequent than to the bones, and in only a few of the reported cases do we find notation of metastases to the lungs. The personal case which I am about to report is rather notable on this account owing to the extensive and diffuse nature of the lung metastases, as seen in the roentgenogram. The ribs and sternum are often involved and Dercum's case (cited by Zadek) is typical of this type.

#### PROGNOSIS AND TREATMENT

Regarding prognosis and treatment, these metastases are often indolent and may exist for a long time without giving any important symptoms; however, sooner or later they will increase, ulcerate and give rise to hemorrhage and various disturbances, according to their site. They may become important enough to cause cachexia and threaten life. Zadek mentions a metastasis present in the sternum for seventeen years and other cases are recorded of very



long duration. My own case was of very long duration, nineteen years. Metastases to the lung were evidently present in 1915.

Radical surgical removal of metastatic thyroid tumors, if accessible, as well as of the primary adenoma is generally indicated, especially on account of the almost universal and sometimes fatal recurrences. In some of the reported cases extirpation of the metastatic tumor resulted in a permanent cure, but recurrence is the rule.

#### AUTHORS' CASE

We have recently had under our care a very interesting case of this kind, which we think desirable to report, with the histologic findings. American literature on this subject is rather sparse.

#### CASE HISTORY

Miss E. D., aged thirty-three, white, entered the American Hospital, Chicago, August 30, 1930, for treatment of a cervical growth.

*Family History:* Mother living and well; father died of heart disease; two brothers and three sisters are alive and well. Some familial antecedents had symptoms pointing to heart trouble and tuberculosis.

*Personal History:* The patient's general health had been fairly good. Her childhood was free from the usual diseases. She menstruated at the age of fifteen and had had no menstrual difficulty. At about this time (1912) she first noticed that her neck was swollen. This condition became progressively worse and she entered a New York hospital where she was operated upon. A short time later the adenopathy reappeared, and increased to an enormous size.

Inquiry at the New York hospital elicited the information that the patient was first admitted and operated upon in 1912. A pathologic report dated September 23, 1912, gives the diagnosis of hyperplasia of the thyroid gland (exophthalmic type). In 1913 the patient was readmitted to the hospital and reoperated on for recurrence of the lesion in the neck. The pathologic report of December 1, 1913, shows that there were then three encapsulated masses, all of which on section showed small calcified hemorrhagic cysts. Microscopically there was typical proliferation of the thyroid tissue which in some respects resembled that

of exophthalmic goiter. There was no definite evidence of malignancy; the pathologic condition was largely that of adenomatous hyperplasia.

In 1914 recurrence of the growth in the neck led to further operation. On the specimen removed then Dr. Ewing reported as follows:

"The section of tissue from the tumor of the neck of the young girl presents, to my mind, the characteristic structure of a papillary adenoma of the thyroid gland. From your description it appears that the tumor arose from an aberrant portion of thyroid tissue. It is not a very malignant process histologically. Thyroid tumors differ from others in showing much capacity to recur locally and even generalize, while retaining an innocent structure. I should think the case deserves vigorous efforts to remove all accessible tissue."

In 1915 the patient was reoperated upon twice for recurrence. First, in May, with a clinical diagnosis of *angiosarcoma*. The post-operative pathologic report on the removed tumor, however, was:

"Papillary adenoma of the thyroid gland, but places appeared suspicious in nature and suggest probable malignant tendency." The second operation (September 1915) was for *recurring angiosarcoma* of the left thyroid. At that time a roentgenogram showed a *profuse carcinomatous infiltration of both lungs*. The patient was treated medically and discharged unimproved.

*Physical Examination:* Poorly nourished female with cervical adenitis. *Head*, negative. *Neck*, cervical adenitis of long duration; much cicatricial tissue especially on left side (see Fig. 1). *Lungs, heart, abdomen, urine, and blood* were essentially negative. The Wassermann and Kahn tests were negative.

*Clinical Diagnosis:* Tumor of neck, probably aberrant thyroid.

*Operation:* Block anesthesia (novocaine). A 3 in. vertical incision was made over the sternocleidomastoid region; a lemon-sized, extremely vascular growth covered externally with numerous enlarged veins was exposed; its attachments were ligated, sectioned and the tumor removed. An attempt was then made to remove a second small tumor mass situated beneath the left sternoclavicular junction, but because of the extreme vascularity this could not be accomplished. The vessels were ligated and, following hemostasis, the incision was closed. The patient was returned to bed in

good condition. Recovery was without any important incident and she left the hospital on September 30. Her condition has remained good up to the present time and there is no apparent evidence of recurrence at the site of removed tumor. Six months after the last operation the patient had gained 10 lb. in weight and apart from some dyspnea on exertion feels well and is at work (see Fig. 4).

Report of the histologic examination of the removed tumor was as follows: (Dr. J. H. Moore).

"The specimen is an irregular mass  $6 \times 5 \times 3$  cm. The surface is smooth with a few small fibrous tags. The cut surface shows a rather definite capsule. The surface is smooth and gray. Many areas are hemorrhagic, others are cystic. There are many calcified areas.

"The microscopic sections show the structure of thyroid adenoma. Some areas are solid with

irregular hyperplasia of the epithelium, with many large cells and cells with hyperchromatic nuclei (see Fig. 2).

"In view of the history of a previous thyroid operation, and the location, it is suggested that this may be a recurrence or metastasis, although complete encapsulation indicates a favorable prognosis."

X-ray examination of the chest showed a very extensive and diffuse infiltration of both lungs (see Fig. 3).

**Pathologic Diagnosis:** From the history of this case and the long duration of the tumor in the neck as well as the roentgen findings of extensive infiltration of the lung in 1915, and from the present histologic and x-ray findings it is believed that the condition may be justly diagnosed as so-called benign metastasizing adenoma of the thyroid gland with metastases in the neck and both lungs.

#### REFERENCES

1. BÉRARD. Nouveau Traité de Chirurgie (Delbet and Le Dentu), 20: Corps Thyroïde, 1908.
2. COHNHEIM. Einfacher Gallertkropf mit Metastasen, *Arch. f. path. Anat.*, (Virchows) 68: 547, 1876.
3. PATEL. *Rev. de Chir.*, 29: 398, 1904.
4. BLOODGOOD, J. C. Adenoma of thyroid. *Surg. Gynec. Obst.*, 2: 121, 1906.
5. WILKENS, G. D., and HEDREN, G. Metastasierende Sköld-körteladenom, *Hygiea*, 71: 934, 1922.
6. BEILBY. Cited by Ginsburg.
7. WEGELIN, C. Henke and Lubarsch, *Handl. b. spez. Path. (Anat. u. Pathol.)*. Berlin, Springer, 1926.
8. HINTERSTOISSER, J. Andenom der Schilddrüse mit Knochenmetastase. *Wien, klin. Wchnschr.*, 42: 496, 1929.
9. GINSBURG, S. Bone metastases of thyroid tumors. *Am. J. Roentgenol.*, 17: 203, 1927.
10. WOLFER. Cited by Patel.
11. VON EISELBERG. Cited by Patel.
12. ZADEK, I. Pathological fracture of neck of femur due to thyroid metastases. *Ann. Surg.*, 77: 689, 1923.
13. MEYER, A. The nature of metastatic tumors of the thyroid. *Worcester State Hosp. Papers*, Baltimore, pp. 95-101, 1912, 1913.
14. KRAFT, J. Ein seltener Fall von metastasierenden Parastruma. *Frankfurt, Ztschr. f. Path.*, 37: 481, 1929.
15. BRINKMANN, E. Metastasierende Parenchymatöse Struma nodosa in ihrer Beziehung zur Unfallbegutachtung. *Klin. Wchnschr.*, 6: 1903, 1927.
16. SHAPIRO, P. F. Metastases of thyroid tissue to abdominal organs. *Ann. Surg.*, 92: 1031, 1930.



# PROLAPSE OF THE RECTUM

## A CONTRIBUTION ON THE ETIOLOGY AND TREATMENT\*

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IN order to make a selection of the proper method by which a prolapsed anus and rectum should be operated, to guarantee a successful termination, it is of vital importance that its cause and origin be known. In conjunction with this, other factors must be considered, such as the general condition of the patient, his age, and his ability to withstand operative interference. We will first discuss the etiology of prolapse of the rectum, and then take up a systematic review of the present-day operations, before we enter into a discussion of a case of a patient whom we operated on, that offers an interesting contribution to the cause and treatment of this condition.

While we must assign due significance to the acquired conditions among the causes of prolapse of the rectum, yet it must be remembered that the congenital anatomical abnormalities, especially those of the cul-de-sac of Douglas, of the pelvic floor, and of the suspensory factors of the sigmoid, play the main rôle. This is true even in acquired cases. An abnormally deep-seated cul-de-sac of Douglas will first make its appearance by an invagination of its posterior wall into the rectum, causing a herniation of the anterior wall of the rectum. If that condition is aggravated by the influence of the normal, and especially by a pathologically increased intra-abdominal pressure, to such a degree that finally the rectum goes through the anus like through the ring of a hernia, then we have before us the picture which Waldeyer has called *hernia perinealis medialis*. In most cases, this deep-seated cul-de-sac is associated with an absence of the normal curvature of the coccyx

and sacrum, which is then more or less straight, so depriving the pelvic floor of a very essential part of its support. There may also be a continuance of the high position of the uterus and bladder, usually found at birth. Furthermore, if there is now present an abnormal weakness of the muscles of the pelvic floor, the resistance of the pelvic diaphragm against the intra-abdominal pressure is diminished to a high degree. If we consider the fact that the sigmoid must be much longer in order that it can reach to the abnormally deep-seated cul-de-sac, then we have all the conditions which can contribute to the formation of a prolapse of the rectum.

In the acquired causes of prolapse of the rectum, we must first mention those conditions which cause a relaxation of the pelvic floor, as all penetrating inflammatory processes of the mucous membrane, as found in a chronic proctitis of any origin; chronic hemorrhoidal afflictions; weakening diseases; neoplasms; injury to the sphincter; and in women, often repeated deliveries, neglected laceration of the perineum and poor repair after hysterectomy. Then there are the nervous diseases which cause a paralysis of the sphincter, as *tabes dorsalis*, multiple sclerosis, and so forth. Following this, are conditions which cause an increased intra-abdominal pressure, as cases of chronic proctitis associated with frequent tenesmus; chronic constipation; dysentery with diarrhea and tenesmus; stricture of the bowel; nasal obstruction due to adenoids, phimosis; stricture of the urethra; hypertrophy of the prostate; stones in the urinary bladder; chronic bronchitis; whooping cough; excessive vomiting; worms; heavy

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lifting, etc. Other etiological factors to be considered are poor hygiene, improper diet, and that modern pernicious habit of forcing children to sit on high toilets until their bowels move. Usually, however, several of these etiological factors are present at the same time, and therefore it is of great import to first ascertain the real origin of the prolapse, and upon this finding, base our operative or conservative treatment.

The reduction of the prolapse is best done in the pelvis-high, or the knee-chest positions. The prolapse is softly massaged, using a well oiled piece of linen, at the same time exerting gentle pressure from its apex toward the anus. After the reduction, the patient should be kept in bed for several days. To avoid a recurrence, treat all those conditions which cause a repeated squeezing, namely, chronic constipation, urethral stricture, stones of the urinary bladder, phimosis, etc. It is best that the patient defecate in the lateral position, and that the action of the abdominal pressure be eliminated by giving an oil, or paraffin enema, immediately before defection. Occasionally, in children, the use of a strap of adhesive plaster across the buttocks, suitable diet, regulation of bowels and general tonic measures, as cod-liver oil, phosphorus, etc., will be successful. At no time, must we neglect to treat, if present, a chronic catarrh of the mucous membrane, a diarrhetic condition, hemorrhoids, etc. Perhaps, if there is laxity of the muscles of the pelvic floor and the sphincter, we may attain some fair results, with faradisation, hydrotherapy, massage and gymnastics. All these procedures can be enhanced, especially in children, by subcutaneous or intramuscular injections of strychnine nitrate 0.001, or ergotin 0.1 to 0.2, or phenol. Also, by enemas of equal parts of tannic acid and alum in a 1 per cent solution; or by enemas of adrenalin (30 drops to  $\frac{1}{2}$  liter). In some cases, cauterization of the prolapsed mucous membrane with silver nitrate may be tried. If, for all that, the prolapse spontaneously appears again,

then one more attempt may be made with one of the numerous bandages recommended by Esmarch, Decker, Bauer, and others.

If we do not attain a good result by these various methods of treatment, if deep ulcers form and produce an increased secretion and continuous pain, if frequent incarcerations with gangrene of the prolapse occur, or even if signs of an intestinal obstruction become apparent, then the operative procedure must be considered as the single successful, or even life-saving treatment. The usual types of operative methods used can be divided into four groups, namely:

1. Methods of narrowing the anus and rectum.
2. Methods of restoration of the pelvic floor.
3. Methods of suspension.
4. Resection of the prolapse.

#### I. METHODS OF NARROWING THE ANUS AND RECTUM

To narrow the enlarged anus and rectum, one can either cauterize the mucous membrane, or diminish in size the lumen of the anus itself. The pararectal injections of ergotin or alcohol are too uncertain in their effects, and so cannot be recommended. Recently, there have been reports of successful injections of hard paraffin in prolapse of the rectum in children (Kephalinos, Spitzky).

The cauterization can be done either by a corrosive, as nitric acid, or silver nitrate, or by the thermocautery. The mucous membrane is scarified from the apex of the prolapse to within a few millimeters of the anus, in four or five longitudinal strips, going as deep as the muscularis.

When only the swollen and loosened mucous membrane of the anus is prolapsed, the same procedures can be employed as in the operations for hemorrhoids. These are the removal of the folds of mucous membrane by ligature, by excision, or by clamp and cautery. Rotter warmly recommends the procedure de-

scribed by Langenbeck. To prevent after-bleeding, both lips of the wound are joined by a continuous catgut suture. A more simple, but yet as efficacious a method, is the crushing of the mucous membrane by means of a Stillé instrument. When we remove, by one of these methods, three or four folds, and leave between them portions of mucosa of sufficient size, then we need have no fear of stricture formation.

Among the various methods used for narrowing the enlarged anus, the simple wire-ring described by Thiersch (1889), is most worthy of a trial. The many operations used, in which much of the mucous membrane, and even the sphincter is sacrificed, and then sutured (Hey, Dupuytren, Dieffenback, Kehrer, König, Roberts, Lee), should be abandoned.

## 2. METHODS OF RESTORATION OF THE PELVIC FLOOR

These operations attempt to correct one of the main etiological factors in prolapse of the rectum, namely, relaxation of the musculature of the pelvic floor. As mentioned before, this condition is frequently associated with an abnormally deep-seated cul-de-sac of Douglas, relaxation of the intestinal wall, and increased intra-abdominal pressure.

Two tasks confront us in the plastic repair of the pelvic floor. Firstly, we must reenforce the relaxed muscles and ligaments of the pelvic floor, and secondly, we must narrow the stretched sphincter and rectum. At times, it may also be necessary to combine these operations with a rectopexy or a colopexy. Verneuil, G. Marchant, Lenormand, Hoffman, McCann, and others have described various techniques. A simple procedure has been perfected by Poppert, from whom we quote:

Median incision from the anus to the sacrococcygeal articulation. Retract the subcutaneous fat until the levator ani and the sphincter are exposed. If necessary, do a temporary resection of the coccyx for better exposure. Now, split the levator ani muscle in the midline until its insertion on the anus, thus

bringing into view, the posterior wall of the rectum. Insert the left forefinger into the rectum to act as a guide. Now take two sutures vertically, through the fascia propria and muscularis of the rectum on both sides of the midline. When these are tied, the posterior wall of the rectum is folded transversely. Do not cut the ends of the sutures, but tie both sides together, thus causing a longitudinal invagination of the rectum, also. In most cases, however, it will be quite sufficient to take two or three transverse sutures, and thus effect a supporting lengthwise fold of the posterior wall of the rectum. At the same time, the lateral walls of the rectum may be fixed to the periosteum of the coccyx, or to the lower border of the sacrococcygeal ligaments. Then the levator ani muscle is sutured in double tier. Finally suture the skin, first inserting a thin rubber drain in the posterior corner of the wound. When the operation is completed, the sphincter and rectum will be found to be narrower, and that the previously thinned pelvic floor will once more form a thick cushion and be distinctly prolonged.

## 3. METHODS OF SUSPENSION

These operations, rectopexy or colopexy, assay to cure the prolapse forever, by suturing the rectum and sigmoid flexure to its normal position. The simple rectopexy, in which the rectum is fixed to the coccyx, will suffice for the early cases only, but for the obstinate, chronic case, it is not suitable, and shows a 50 per cent recurrence, even when it is modified according to König, who cuts a wedge out of the circumference of the anus. And so, in all these cases, we should combine the rectopexy with the infolding of the intestinal wall, the narrowing of the sphincter, and the restoration of the pelvic floor.

Ekehorn has described a very simple and commendable procedure which is applicable only in children. Under general anesthesia, the prolapse is pushed back, and the left forefinger introduced into the rectum. Then a large aneurysm needle is passed from outside, close to the lower and lateral end of the sacrum into the rectum and brought out through the anus under the guidance of the finger. The needle is

threaded with strong silk and pulled out again. In a similar way, the needle is passed in on the other side of the sacrum, and the other end of the thread pulled out to the back, so that the loop of silk now lies in the rectum. The free ends are pulled up, and tied across the sacrum. The suture is removed after fourteen days. No special after-treatment is necessary. Of course, the question of infection will be raised, but according to Tölken, outside of a slight rise in temperature, no serious complications have been observed.

The final results of the colopexy, as introduced by Jeannel in 1889, are not satisfactory, though it counteracts the hernia-like invagination of the anterior rectal wall, by the fixation of the pelvic colon to the anterior abdominal wall. However, it does not take into consideration the pathological condition of the pelvic floor, and so we find gathered in the literature, reports of more than 50 per cent relapses (Pachnio, Lenormand). This method should be used only as a supplement to the plastic repair of the pelvic floor in severe cases in which the latter operation would not suffice. Mummery reports good results with his operation of tamponade of the retrorectal space. There are others who advocate the passing of sutures around the sacrum, as described by Tuttle. Recently Kümmel has recommended the hitching up of the elongated pelvic colon to the anterior longitudinal ligament of the spine. This method need not be combined with the narrowing of the anus, or with a plastic of the pelvic floor.

In Kümmel's operation, the abdomen is opened by a midline incision, the patient in the pelvis-high position. The rectum is pulled up as high as possible, and fixed to the promontory by three silk sutures which take in 3 cm. of the anterior longitudinal ligament, and then goes through the serosa and muscularis of the rectum at the point of the insertion of the mesocolon. Sudeck has modified this procedure by freeing the rectum in the sacral excavation, then sew-

ing the stretched rectum to the promontory according to Kümmel. He also sutures the lengthwise incision of the peritoneum, in a transverse direction, thereby considerably lifting the bottom of the cul-de-sac of Douglas.

*Technique of Colopexy:* The patient is in the Trendelenburg position. The abdomen is opened by a 12 to 15 cm. long left rectus incision. If there is difficulty in locating the sigmoid flexure, introduce a thick metal probe into the rectum as high as possible, to bring it into view. Now make traction on the flexure until the prolapse is completely reduced, and the anus retracted. Then the colon is fixed. This can be done to the anterior abdominal wall (Jeannel, Bogdanik, von Eiselsberg) or to the muscles covering the iliac bone, which are denuded of the parietal peritoneum to give a larger and stronger surface for adherence (Rotter, Lenormand, Ball, and others). For that purpose, the retroperitoneal tissue is exposed by a longitudinal incision, or by the excision of an elliptical flap of the parietal peritoneum on the fossa iliaca. The stretched colon is placed on this surface and sutured on both sides to the edges of the peritoneum going through the retroperitoneal tissue too.

#### 4. THE RESECTION OF THE PROLAPSE

This operation is either restricted to the removal of the mucous membrane, or it may consist of total resection of the prolapse.

The resection of the mucous membrane according to Rehn-Delorme, is done in the following manner. The prolapse is pulled down with clamps, and the mucosa thoroughly cleansed. An incision is made around the anus, at the mucocutaneous border, penetrating only the outer layer. The mucous membrane is now cautiously dissected downwards to the apex of the prolapse, in the form of a cylinder, always being certain not to go deeper than the muscularis. Interrupted catgut sutures are now inserted from the edge of the skin,

through the muscularis to the edge of the attached mucous membrane. As these are tied, the dissected mucosa is removed, step by step. In this way, the muscularis is brought up against the external sphincter in the form of a pad, and thus tends to support its action. The muscular pad retracts by degrees, so that the normal contour of the anus is not disturbed. The great advantage of this method over that of total resection, is that the peritoneal cavity is not opened, and the procedure itself is not a very severe one. The post-operative finding is a solid, firm pelvic floor, which meets every physiological demand, and grants a fair amount of immunity against recurrence.

Amputation of the prolapse by cautery, or by the Ekraseur is no longer used and that of ligature (Allingham, Weinlechner) is only rarely done.

The technique of total resection of the prolapse as improved by Mikulicz in 1889, is as follows:

Two deep traction sutures are taken at the apex of the prolapse. Then starting anteriorly, 2 cm. away from the anus, the outer intestinal tube is incised, layer by layer, making sure to catch all bleeding vessels. Then open the peritoneum, reduce any prolapsed intestines if present, and close again. Then incise the anterior part of the inner tube, layer by layer. Now suture both walls together, by a through and through continuous suture, which also acts as a hemostatic suture. Leave the suture ends long, and use as tractors. In the same manner, cut through the posterior half of the prolapse. Here, however, one usually does not find peritoneum any longer, but the mesocolon, with its numerous vessels. These must be caught and ligated before cutting, as they may retract beyond reach. After the entire circumference of the stump has been sutured, the sutureline is covered with an antiseptic powder and the short stump is reduced into the anus.

In some cases of habitual prolapse of the rectum, there may exist such a dispro-

portion between the outer and inner tubes, that an exact suturing is scarcely possible. In such cases, a cleft may be left unsewn in the posterior section of the outer tube and a strip of gauze inserted.

In the after-treatment, it is very important to avoid defecation for about one week. The mortality of the operation is very high (10.9 per cent,<sup>1</sup> Lenormand). The chief dangers are hemorrhage, peritonitis, and the length of the operation. It must also be remembered, that a recurrence is possible, as is a postoperative stricture. Therefore this operation should be used only in desperate cases, when the prolapse is ulcerated to a large degree; when it is gangrenous; or when a neoplasm is the cause of the prolapse.

We wish to present a case, which we feel will be very interesting and instructive.

I. A., Female, thirty-six years of age. For the past nine years patient complained of dyschezia, with prolapse of the rectum during defecation. In the beginning, the prolapse reduced itself spontaneously after defecation, but of late, manual reduction became necessary. Ever since the time the prolapse had ceased reducing itself spontaneously, the patient had noticed mucus and blood in the stools.

*Findings:* Patient short; large-boned; much adipose tissue; skin pasty; bradyphasia. Patient is very timid and gives the impression of an inferior intellectuality. Right pupil reacts slower than the left. Tremor of the hands. Spastic walk, uterus is anteфлекed, freely movable, normal in size, adnexa are negative.

*Rectal Examination:* Protruding from the anus is a portion of the rectum, 8 cm. long, the mucous membrane of which is dark red, and is covered with numberless petechiae, strips of mucus and spots of pus. The prolapsed rectum can be very easily reduced, as the sphincter is completely paralyzed. For this reason it is impossible to keep the rectum in reduction. The perianal skin shows signs of an eczema, the levator ani muscle shows no power of contractability. The pelvic floor is remarkably thinned.

*Diagnosis:* Multiple sclerosis. Prolapse of rectum.

*Note:* The patient insists on operation because she describes the prolapse as a torture

being unable to control either defecation or flatulation.

The etiological factor in this case, was very simple, namely the multiple sclerosis. This caused a weakness of the sphincter, resulting in a complete ineffectiveness. It also undoubtedly aggravated any pre-existing relaxation of the pelvic floor. When the prolapse started, the exposure of the mucous membrane caused a secondary proctitis, with all its concomitant symptoms of diarrhea, tenesmus and increased intra-abdominal pressure. We had a vicious cycle which gradually produced a prolapse of such proportions.

We were then confronted with several problems as to the proper surgical procedure to pursue. We could not remove the underlying etiological factor, the multiple sclerosis, surgically. We could expect just as little from a restoration of the pelvic floor because of the completely atrophic condition of the musculature. Also, the perianal eczema countermanded any major surgical procedure on the perineum. Thus we had to be guided by the peculiarities of the case on hand. First we had to obtain a fixation of the rectum without opening the perineum, to avoid a secondary infection from the eczema, and then we had to narrow the anus and at the same time reinforce the sphincter.

We chose the abdominal rectopexy. On August 23, 1928, under general ether anesthesia, with the patient in Trendelenburg position, the peritoneum was opened by a left pararectus incision 10 cm. long. We were immediately confronted with an abnormally elongated sigmoid colon. The cul-de-sac of Douglas was also abnormally deep-seated. By pulling up on the pelvic colon, we were able to reduce the prolapsed rectum completely, and while the colon was thus held in a stretched position, the sigmoid was fixed against the promontory by three deep sutures. These same sutures served to elevate the floor of the Douglas cavity about 5 cm. We then had left a long loop of sigmoid, which was reduplicated on itself. Between the two loops we

then made an enteroanastomosis, and fixed the entire sling against the parietal peritoneum, by taking several U-shaped sutures which were tied above the aponeurosis of the external oblique. The abdomen was then closed in layers.

For the narrowing of the anus, we used the Thiersch procedure, as modified by Peyer, who used a strip of fascia lata instead of wire. A strip of fascia lata, 16 cm. long and 1 cm. wide was removed from the lateral side of the left thigh. The patient was then put up on the Steinschmitt position and four short incisions were made around the anus, one anteriorly, one posteriorly, and one on each side laterally. With the left forefinger in the anus as a guide, the skin between these incisions was undermined by means of a curved clamp. The strip of fascia was pulled through so that both ends came out through the posterior incision. The fascia was tied over the tip of the forefinger in the anus, and the knot anchored with a catgut suture. The four incisions were then sutured.

The after treatment consisted of a daily dose of one tablespoonful of oleum ricini, to assure a soft defecation. The post-operative course was more or less uneventful. The first dejection took place on the third day and was followed by a marked diarrhea, the patient having ten to twelve stools a day. Notwithstanding this, the narrowed anus held securely, without even showing the slightest prolapse of mucous membrane. On the tenth day after operation, the patient got out of bed and for the first time in many months was able to control her defecation and flatulation. The patient was seen again on the first of October. Digital examination of the rectum revealed a large and distinctly contractable sphincter that just admitted the finger. No sign of vaulting of the anus could be detected even after utmost straining on the part of the patient. She now has two regular movements a day and experiences absolutely no difficulties.

We attributed several factors to this very excellent result to: (1) we were assured



of a large and durable adhesion between the rectum and the sacrum, by fixing the stretched colon to the promontory; (2) the entero-anastomosis, and the anchoring of the sigmoid-sling to the parietal peritoneum also tended to exclude the possibilities of a recurrence; (3) the narrowing of the anus by means of living tissue allowed us to reap all the benefits of the simple Thiersch method without incurring any of its disadvantages.

## REFERENCES

1. BAUER, A. Der heutige stand der Behandlung des Rektalprolapses. *Ergebn. d. Chir. u. Orthop.*, 1912, 4: 513-612; Berlin, Springer.
2. BECKER. Ein Beitrag zur operativen Behandlung d. Mastdarmprolapses. *Beitr. z. klin. Chir.*, 41: 158-166, 1903.
3. DELORME, M. Sur le traitement des prolapsus die rectum totaux, par l'excision de la muqueuse rectale ou recto-colique. *Bull. et mém. Soc. de Chir. de Paris*, 26: 499, 1900.
4. HOFFMAN, C. Zur Pathologie des Prolapsus Ani et Recti und seine operative Behandlung durch Beckenboden-plastik. *Zentralbl. f. Chir.*, 24: 667-669, 1906.
5. KÜMMEL, H. Zur Operation des hochgradigen mastdarmvorfalles. *Zentralbl. f. Chir.*, 25: 465-469, 1919.
6. LUDLOFF, K. Zur Pathologie und Therapie des Rektumvorfalles. *Arch. f. klin. Chir.*, 59: 447-457, 1899; 60: 717-811, 1900.
7. MIKULICZ, J. Zur operativen Behandlung des Prolapsus recti et coli invaginati. *Arch. f. klin. Chir.*, 38: 74-97, 1889.
8. MOSCHCOWITZ, A. V. The pathogenesis, anatomy and cure of prolapse of the rectum. *Surg. Gynec. Obst.*, 15: 7-21, 1912.
9. LOCKHART, MUMMERY, J. P. Diseases of Rectum and Colon. William Wood & Co., N. Y., 1923.
10. PACHNIO, F. Dauerresultate Der Kolopexii bei Hochgradigen Rectumprolaps. *Beitr. z. klin. Chir.*, 45: 300-334, 1905.
11. POPPERT, P. Operationen am Mastdarm in Bier, Braun, Kümmel. *Chirurgische Operation*. Leipzig, Johann Ambrosia Barth, 1923, 4: 110.
12. ROTTER. Zur Kolopexie bei Prolapsus recti. *Zentralbl. f. Chir.*, 37: 1015, 1903.
13. SCHMERZ, H. Die operative Behandlung des mastdarmvorfalls mittels Fascienplastik. *Beitr. z. klin. Chir.*, 13: 346-371.
14. TÖLKEN, R. Die Ekehornische Operation des Mastdarm Vorfalls bei Kindern. *Deutsche Med. Wchnschr.*, 15: 427, 1915.
15. TUTTLE, J. P. Diseases of Anus, Rectum and Pelvic Colon. N. Y., Appleton & Co., 1903.



# INTESTINAL OBSTRUCTION\*

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**E.** B., a female aged sixty-seven, was admitted to the Clearfield Memorial Hospital May 4, 1929, complaining of pain in the abdomen with nausea and vomiting. She had had her usual health until two weeks before except that she had noticed that she had been losing weight slowly for the past two years. Two weeks previous to her admission she began to have slight pain and distress in her lower abdomen. She took castor oil and salts alternately which produced good results but did not relieve the abdominal distress. The purgatives taken five days and three days previous were followed by several loose bowel movements. Two days before castor oil and salts taken again gave her no results. An enema taken the day before came back almost clear. This was followed by more severe pain in the abdomen with nausea and vomiting. She had had no bowel movement for three days. The pain was very severe when she was admitted. She stated that she had had high blood pressure for a long time and that it was taken the day before and was 220/100.

The physical examination revealed the eyes, ears and nose normal, artificial teeth, submerged tonsils, a slight thyroid enlargement, chest normal, heart normal, abdomen rigid and tender without localization, vagina normal for a woman of her age; pelvic bimanual examination was impossible on account of rigidity; rectal examination showed no abnormalities except for a few external hemorrhoids and the rectum collapsed, no gas. The extremities were normal.

The laboratory findings were as follows: Blood count: hemoglobin 79 per cent, red blood cells 3,950,000, white blood cells 9,600, polymorphonuclears 81 per cent, lymphocytes 15 per cent, eosinophils 3. Blood chemistry: urea-nitrogen 43.43 mg., creatinine 2.5 mg., sugar 176 mg., chlorides 470.5 mg. Kahn test was negative.

Diagnosis: Obstruction of lower bowel, peritonitis.

The patient was operated upon under spinal anesthesia. The findings were as follows: pelvic abscess, pelvic peritonitis from puncture of the sigmoid by a toothpick which was protruding from the perforation, congested

appendix. The following was carried out: removal of toothpick, evacuation of pus. At the site of puncture, the walls of the gut were the seat of inflammatory edema and were very friable. It was impossible to suture the appendices epiploicae because they were so edematous and friable and impossible to use in the closure of the perforation; therefore the sigmoid was sutured to the posterior wall of the uterus, using the uterus to stop the leak. In the wound the appendix appeared red, thickened and edematous and was removed for fear of post-operative complications. A Coffey drain was passed on either side of the pelvis, rubber tissue separating the gauze and drainage from the sutured area. Peritoneum was closed loosely around the gauze with chromic catgut sutures. Other structures of the abdominal wall were allowed to remain open, packed with iodoform gauze external to the peritoneum.

Following operation the patient had a rather stormy time with adynamic ileus and pulmonary complications. As the wound had been left open for drainage, time was also required for healing. The patient was discharged from the hospital in eminently satisfactory condition at the end of thirty-five days and has remained well.

This was an unusual case of intestinal obstruction, due to perforation by a toothpick, which was partly caused by the mechanical effect of swelling from edema occluding the lumen and partly by paralytic or adynamic ileus from peritonitis. The patient was extremely ill the case being complicated by more or less generalized peritonitis, pulmonary complications, the age of the patient, sixty-seven; yet, she showed marked resistance and her health is normal for her age two years following operation. Last, but not least, this shows the surgical expediency of not trying to suture friable, edematous, infected gut but the utility and time-saving element of suturing another organ covered with peritoneum over the perforation.

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# APPENDICITIS IN CHILDREN\*

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THESE are successive cases of patients whom I have operated on at the Norwegian Hospital, Brooklyn, but are not part of our general ward service.

## EMBRYOLOGY

The anlage of the cecum buds out as a small evagination on the caudal arm of the embryonic intestine at six weeks of age. At the eighth or ninth week the large intestine increases rapidly in diameter and the cecum is carried across to the right side of the abdomen and comes to lie caudal to the liver.

The transverse, descending and sigmoid colon are recognizable in the third month. After the fourth month the portion to which the cecum is attached grows downward in the right side of the abdominal cavity forming the ascending colon. The cecum increases uniformly in size for a time and then suddenly the proximal end increases more rapidly than the distal end. The distal end remaining slender forms the vermiform appendix.

Structurally the appendix is composed embryologically of two layers, entoderm which lines the lumen, and splanchnic mesoderm which borders on the body cavity. From the mesoderm the lymphatic tissue corresponding structurally to the tonsil is developed. The appendix especially is the seat of extensive lymphatic tissue formation.

## ETIOLOGY AND PATHOLOGY

From a study of the cases in this report it appears that acute upper respiratory infections in children are the causative agent in appendicitis. Kretz considers the hematogenous infection of the appendix wall by bacteria transported

from infected tonsils as the common origin of appendicitis.

W. G. MacCallum states that apparently the streptococcus accompanied by the colon bacillus has been found most often in diseased appendices. Acute upper respiratory infections are quite uncommon in the newborn. In fact they become more prevalent with each year of life. This is true also of the incidence of appendicitis from birth up to twenty years of age. There is a relationship between the occurrence of tonsillar infections and appendicitis. Appendicitis probably is a complication of tonsillitis in the same sense as is rheumatic fever or endocarditis.

During an attack of tonsillitis a hematogenous infection may take place. If it does the intestine having an abundance of lymphatic tissue similar to that in the tonsil and the appendix a proportionately greater amount is prone to pick up the infection. When this occurs a reaction takes place, inflammation. This reaction causes swelling, kinking, obstruction of the lumen, with the resulting appendicitis. If the predominating infection is in the intestine and not in the appendix, the reaction is not sufficient to cause a surgical abdomen and the condition passes as an abdominal grippe. The resulting degree of appendicitis depends upon the severity of the infection and the strain of the infecting organism.

Chronic appendicitis is caused by attacks of less severity in which the mild acute attack subsides producing round cell infiltration, thickening and scarring. Frequently this type is called a bilious attack or an upset stomach by the clinician. When this type comes to operation it is usually the result of a fecalith or stasis producing

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a pressure necrosis and secondary infection by *B. coli*. It is usually of the slow, insidious onset in children, but the mother has caused the appendix to perforate by the free use of cathartics.

If the real acute case is operated before suppuration takes place there is free fluid in the abdomen and the appendix is swollen and injected. The pathologists report in this type of case is frequently one of chronic appendicitis. This diagnosis could not be made if a microscopical study was made of the appendix.

#### INCIDENCE

McCash in 1000 cases of appendicitis reports:

- 51 patients between five and ten years of age.
- 17 patients under five; of these 4 were under two years.

Churchman in 1223 cases of appendicitis reports:

- 50 patients between five and ten years of age.
- 9 patients under five years.

Curtis Ginn reports 97 cases of appendicitis:

- 13 patients were between five and ten years of age.
- 6 patients under five years.
- 4 of these 19 children died.

#### SYMPTOMS

Abdominal pain was present in all cases, although in only one case was it severe enough for the child to voluntarily stay in bed. Nausea, unaccompanied by vomiting occurred only in one case. Vomiting occurred in 82 per cent of the cases. Repeated vomiting occurred only in the peritonitis cases. Bowels:

- 1 child was constipated.
  - 2 had a diarrhea.
  - 6 were given cathartics; 2 were given enemas because of the abdominal pain.
- Of the 8 patients with peritonitis, 4 had received cathartics and one an enema. One patient with gangrenous appendicitis had received a cathartic.

Urination frequency was complained of by one child. Upper respiratory infections: 4 patients complained of sore throat, although on examination 13 of the 18 patients in this series were found to have acute upper respiratory infections with sore throat. Fever was present in all cases. It was influenced more by the severity of the infection than the amount of destruction or peritonitis.

#### DIAGNOSIS

Routine physical examination is necessary to rule out other conditions and to ascertain the condition of the throat, as children rarely complain of pain with tonsillitis. If a child starts vomiting or complains of abdominal pain forty-eight hours after an upper respiratory infection the diagnosis is to be suspected.

The child usually appears too sick for the physical findings.

If the abdomen is rigid with distinct localized tenderness, there is no difficulty in diagnosis providing pneumonia has been ruled out. Usually, however, the abdomen is soft, though the child may hold it spastic. In this type pyelitis must always be considered. In this group of 18 cases only 5 had some degree of rigidity. There is usually some tenderness in the lower right quadrant.

The diagnosis is always made or confirmed by a rectal examination. The finger is gently inserted into the anus until it reaches above the fixed portion of the rectum. The left side of the pelvis is then palpated to determine the normal reaction. The finger is then swept over to the right side and the appendix area palpated. If there is a mass there is no difficulty. The usual findings are extreme tenderness and slight resistance due to the infiltration about the appendix. The tenderness on the left side is then compared with that on the right by bimanual palpation. With this method the right sided tenderness becomes very severe. If this extreme tenderness is illicit a diagnosis of appendicitis should be made. The appendix

is more frequently palpated in the pelvis in the female than in the male.

Blood count is of practically no value, although it is usually increased. A count of 4200 polymorphonuclears was found in one case of general peritonitis and in another case complicated by grippe.

When the diagnosis is made the child should be operated upon immediately whether peritonitis is present or not.

#### OPERATION

Children stand peritonitis better than adults, but they cannot stand dehydration.

Age	Sex	Abdominal Pain	Condition of Abd.	Tenderness	Rectal Tend.	Temp.	Blood Count	Condition of App.	Days Hosp.
2	M	3 days	Rt. rectus rigid	L.R.Q.	Pres.	103	19,000 89%	Ruptured abscess; peritonitis	21
2½	F	2 days	Soft	L.R.Q.	Pres.	101 <sup>6</sup>	none	Ruptured; gen. perit.	died
3	F	1 day	Soft	L.R.Q.	Pres.	103 <sup>2</sup>	16,200 91%	Acutely inflamed	15
4	F	1 day	Soft	L.R.Q.	Pres.	101 <sup>6</sup>	16,700 90%	Gangrenous; gen. perit.	14
4½	F	22 days	Soft	L.R.Q.	Pres.	101 <sup>4</sup>	16,100 87%	Ruptured; gen. perit.	21
4½	M	7 days	Dist.	L.R.Q.	Pres.	101 <sup>6</sup>	36,000 90%	Ruptured; gen. perit.	died
5	F	1 day	Soft	L.R.Q.	Pres.	103	12,100 80%	Acutely inflamed	13
6	M	6 hrs.	Board like	L.R.Q.	Pres.	102	11,400 87%	Acutely inflamed	15
6	M	1 day	Rt. rectus rigid	L.R.Q.	Pres.	102 <sup>6</sup>	none	Acutely inflamed	10
7	M	1 day	Soft	L.R.Q.	Pres.	102	6,000 70%	Acutely inflamed	12
7	M	1 day	Soft	L.R.Q.	Pres.	104	20,900 87%	Acutely inflamed	13
7	F	2 days	Soft	L.R.Q.	Pres.	102	21,000 91%	Ruptured; pel. perit.	25
8½	M	3 days	Soft	L.R.Q.	Pres.	99	7,800 68%	Acutely inflamed	10
11½	F	1 day	Rt. rectus rigid	L.R.Q.	Pres.	99	none	Gangrenous	16
12	M	1 day	Rt. rectus rigid	L.R.Q.	Pres.	99	4,200 72%	Gangrenous, gen. perit.	40
12	F	1 day	Soft dist.	lower abd.	Pres.	99	23,350 89%	Ruptured; gen. perit.	27
12	F	1 day	Soft	L.R.Q. kidney	Pres.	99 <sup>6</sup>	10,550 85%	Acutely inflamed	12
12	M	4 days	Soft	L.R.Q.	Pres.	101 <sup>6</sup>	4,200 60%	Acutely inflamed	14

Prior to operation they should be given one or two clyses of saline solution.

A right rectus incision is used in all cases where gangrene, abscess or peritonitis is expected. A McBurney incision is used in acute cases where no complications are expected. Transverse incisions are not used as the resulting scar is too conspicuous. The incision should be small, but ample to give good exposure.

The entire area should be walled off before disturbing the cecum or the appendix.

The appendix should always be removed.

Cigarette drains are used when necessary one being inserted into the pelvis and another at the site of the appendix. Rubber tubes should not be used as the hard surface causes considerable infiltration in the resulting sinus. This delays healing of the sinus after the tube is removed. The Penrose drain is too small to give ample drainage in abscess or peritonitis cases.

Postoperatively 1 or 2 doses of codein are given to allay restlessness. Saline clyses are given freely. Milk, cereal and orange juice are given in small amounts after twelve hours if the child retains sips of warm water. Drains are freed at the end of forty-eight hours and removed as soon as the case warrants.

Ether is the anesthesia of choice. Anesthetics used:

Ether.....13 cases

Spinal..... 1 case

Ethylene..... 1 case

Nitrous oxide.. 1 case

Novocaine..... 2 cases, local infiltration in children four and one-half and seven years old.

#### CASE REPORTS

The following case histories are given in brief to illustrate some of the types of appendicitis occurring in children.

CASE I. No. 37666. Age twelve. Admitted April 8, 1930.

The child had not felt well for four days. There was no nausea or vomiting, but some abdominal pain. Fever and cough were present.

*Diagnosis:* Grippe; acute appendicitis.

*Physical examination:* Tonsils reddened, enlarged. Few râles in chest. Abdomen soft. Slight tenderness over McBurney's point. Very tender on rectal examination. Blood count, 4200; polymorphonuclears 60 per cent, mononuclears 40 per cent.

The diagnosis was confirmed by a consultant.

*Operation:* Spinal anesthesia, McBurney incision. The appendix was thickened, swollen, injected, covered by lymphatic exudate.

The patient was discharged on the twelfth day as recovered.

CASE II. No 39287. Age four and one-half. Admitted August 20, 1930.

The patient was taken ill four days previously with a cold. He had had some fever and cough. The day before admission to the hospital he vomited six times and then had some abdominal pain. The bowels moved three to six times daily; loose, green, mucoid. He received a dose of castor oil.

*Physical examination:* Tonsils were markedly injected and edematous. Abdomen was soft, and tender in the lower right quadrant; very tender on rectal examination. Blood count, 16,800; polymorphonuclears 87 per cent, mononuclears 13 per cent.

*Diagnosis:* Grippe and acute appendicitis. The consultant considered case one of grippe only. Case was watched by the consultant and myself.

On August 24 a definite mass was felt and operation was decided upon.

*Operation:* Ether anesthesia; right rectus incision  $2\frac{1}{2}$  inches long. The muscle was edematous, the omentum dull; there was free pus throughout the peritoneal cavity. The appendix was found behind the bladder, perforated. Coils of intestine were about the appendix, acutely angulated and held together by plastic lymph. The abdomen was drained.

*Pathological diagnosis:* Acute appendicitis.

The patient was discharged on the twenty-first day as recovered.

CASE III. No. 39263. Age six. Admitted August 8, 1930.

The patient had had cramp-like pain in the abdomen of six hours' duration. Mother had forced vomiting. The child has had repeated sore throats and a mild attack of appendicitis two years ago.

*Physical examination:* The abdomen was board like throughout; tender over McBurney's point; very tender on rectal examination. There was no sore throat; chest was negative.

Blood count 11,400; polymorphonuclears 87 per cent, mononuclears 13 per cent.

*Diagnosis:* Acute appendicitis.

*Operation:* The appendix was removed through a 2½ inch right rectus incision. Free straw colored fluid was present in the abdomen. The appendix was adherent to the cecum, distal end swollen, engorged, covered with lymph.

*Pathological diagnosis:* Chronic appendicitis.

The patient was discharged on the fifteenth day as recovered; he had developed an infected wound.

CASE IV. No. 38823. Age two. Admitted July 12, 1930.

The child had a fever and sore throat four days previous. On July 9, he complained of pain in the abdomen. On July 10 he was seen by me.

*Physical examination* showed no abdominal, but considerable rectal tenderness. A positive diagnosis was not made at the time. The child vomited after the rectal examination. When seen again by me on July 12, a diagnosis of acute appendicitis was made.

*Physical examination:* The throat was red and inflamed. The abdomen was soft and slightly distended; extreme tenderness on rectal examination. Blood count 19,000; polymorphonuclears 89 per cent, mononuclears 11 per cent.

*Operation:* Ether anesthesia, 2 inch right rectus incision. The appendix was retrocecal, adherent to the cecum. When the adhesions were freed about one ounce of pus was evacuated and a fecalith the size of a pea was found lying alongside a gangrenous, perforated appendix. The stump of the appendix could not be invaginated in this case. Drainage was used.

*Pathological diagnosis:* Acute appendicitis.

The child was discharged on the twenty-first day, recovered.

#### MORTALITY

In this series of 18 cases one death was not directly attributable to appendicitis and is not included in the mortality rate. This boy, four and one-half years of age, had pneumonia of the entire right lung and of the left base in addition to a general peritonitis with marked distention when first seen. He was in extremis and operation was performed under local anesthesia in the hope that by drainage of the abdomen some of the toxicity would be relieved. Of the 17 other cases shown in the table:

1 case was of abscess with localized peritonitis

1 case of pelvic peritonitis

6 cases of general peritonitis

8 cases of acute appendicitis

1 case of gangrenous appendicitis.

The other death was in child aged two and one-half who had been sick four days. The tonsils were badly diseased. The appendix was retrocecal, ruptured, with a general peritonitis. The child took ether anesthesia very poorly, the operation having to be stopped while carbon dioxide, oxygen and artificial respiration were given. Immediately after the operation the child's temperature rose to 108°F., and he died on the fourth day of a post-operative pneumonia.

The mortality rate was 5.8 per cent.

#### CONCLUSIONS

Appendicitis in children is a complication of upper respiratory infections.

Children stand peritonitis very well.

Free use of saline clyses is essential.

Operation should be performed as soon as the diagnosis is made.

The appendix should always be removed.



# STRICTURE OF THE RECTUM

WITH SPECIAL REFERENCE TO STRICTURE IN THE COLORED RACE

REPORT OF 160 CASES\*

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HOUSTON, TEXAS

THERE have been a great many papers written on stricture of the rectum and the various etiological factors discussed. The problem of stricture of the rectum in the colored race, as it presents itself to me, is somewhat different from that in the white. This has been mentioned by several men who live where there is a large negro population, notable contributions having been made by Day<sup>5</sup> and Rosser.<sup>17</sup> To Rosser, we are indebted for advancing the theory or fact that the tissue of the negro is different from that of the white and that they have a marked scar-forming tendency, which he terms a "fibroplastic diathesis." I do not doubt that this is the basis of stricture formation in the colored race, and all that is needed for an excess of fibrous tissue to form is for them to have an injury of some kind. Whether this be traumatism or bacterial invasion with ulceration makes no difference. We see strictures of the urethra in the colored men more than in any other race, but strictures of the rectum occur much more frequently in the colored women.

I believe that we have bacterial invasions of the rectum in the white and Mexican races almost as frequently as we do in the colored, but there is not that marked tendency to scar formation in these two races as there is in the colored. Two years ago,<sup>9</sup> I brought to the attention of the profession the fact that there is a marked frequency of gonorrhea of the rectum in both white and colored. In fact, I believe that gonorrhea of the rectum occurs in 35 per cent or more of all females who have a gonorrheal vaginitis.

I am discussing in this paper 160 cases of stricture of the rectum which have come under my observation. These cases have come from my own clinics at the Jefferson Davis Hospital and the Hermann Hospital, my private practice, and from the clinics of Dr. Hugh C. Welsh at these hospitals. I have made a number of comparative charts in order to get more accurate data on the number of rectal cases compared with all admissions to the clinic, then the percentage of stricture cases, together with the race percentage and the sex percentage. We have Wassermann tests and smears wherever possible, but in a number of the first cases seen, we did not have either Wassermann tests or smears.

From Table 1, you will note that we had over 34,000 white patients, over 42,000 colored, and over 14,000 Mexicans, a total of 91,446 cases. There were 2747 rectal cases from this number, 1970 of which were white, 726 colored, and 51 Mexicans. You will note there was a marked difference in the proportion of rectal cases in the colored as compared with the Mexicans. There were more white males than white females, but more colored females than colored males. The total sex percentage of all races combined was about the same. We would probably have had more admissions of the colored to the various hospitals if we had had the accommodations. We were never able to admit as many of these patients as we should, because of the lack of beds. In private practice, I rarely ever see a colored patient; therefore, cases seen in my private practice represent people that we meet in the ordinary walks of life.

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In Table II, there were only 113 rectal strictures for comparison, as there were 47 cases of stricture listed prior to 1928

In Table III, which is a study of the series of 160 cases, the males constitute 15.82 per cent of the whole and the females

TABLE I

TOTAL NUMBER OF CASES AND NUMBER AND PERCENTAGE OF RECTAL CASES FROM HERMANN HOSPITAL, JEFFERSON DAVIS HOSPITAL, AND PRIVATE PRACTICE

Origin of Material	Number of Cases	Race	Race Per Cent of Cases	Number and Per Cent of Rectal Cases	Race Per Cent of Rectal Cases	Sex Per Cent of Rectal Cases Race Segregated		Total Sex Per Cent of Rectal Cases	
						Male	Female	Male	Female
Hermann Hospital Clinic 1926, 1927, 1928, 1929, 1930	12,455	White	8818 or 70.79	357 or 3.89	196 or 54.9	73 or 20.44	123 or 34.45	114 or 31.92	243 or 68.08
		Colored	3637 or 29.20		161 or 45.09	41 or 11.48	120 or 33.61		
Jefferson Davis Hospital Clinic 1928, 1929, 1930	75,630	White	22,662 or 29.98	939 or 1.24	342 or 36.42	229 or 24.38	113 or 12.03	441 or 46.96	498 or 53.03
		Colored	38,397 or 50.76		546 or 58.14	184 or 19.59	362 or 38.55		
		Mexican	14,571 or 19.27		51 or 5.43	28 or 2.98	23 or 2.44		
Private Practice 1927, 1928, 1929, 1930	3361	White	3308 or 98.42	1451 or 43.17	1432 or 91.79	833 or 57.40	599 or 41.28	842 or 58.02	609 or 41.97
		Colored	53 or 1.57		19 or 1.3	9 or .62	10 or .68		
Total	91,446	White	34,788 or 38.04	2747 or 3.0	1970 or 71.71	1135 or 41.31	835 or 30.39	1397 or 50.85	1350 or 49.14
		Colored	42,087 or 46.02		726 or 26.42	234 or 8.51	492 or 17.91		
		Mexican	14,571 or 15.93		51 or 1.88	28 or 1.37	23 or .83		

on which we were unable to get the comparison of the number of cases seen and the rectal cases. You note the rather marked difference in the percentage of stricture cases in the charity clinics and in private practice. In Hermann Hospital there was 12.6 per cent of the rectal cases that had strictures, in Jefferson Davis Hospital, 5.32 per cent, and in private practice, 1.25 per cent, a total of 4.11 per cent of rectal cases that had strictures. Of these 113 stricture cases, 21 were white, 90 colored, and 2 were Mexicans. You can see that of all the colored, only nine were males and eighty-one were females. Therefore, of this series of strictures, 72 per cent were colored females. Of the total sex percentage, 19 or 16.81 per cent were male, and 94 or 83.18 per cent were female.

84.17 per cent. In the race chart there was 16 per cent white, 80 per cent colored, and 3 per cent Mexicans. In the chart showing segregation of race and sex the occurrence of stricture in the white male and colored male was about the same, but in the white female and colored female there was a marked discrepancy. There were only 12 white females against 116 colored females, yet the number of white females seen against colored was 2 to 1. The occurrence of stricture in the Mexican male and female seems to be lower than either the white or colored.

The study of the ages of these cases is interesting. The 2 cases between one month and one year old were congenital. Most of the cases of stricture occurred between the ages of twenty-one and thirty years,

there being 66 in this period, and 53 between the ages of thirty-one and forty years. We find more cases between these

in a study of the pathology. This will also give some more details on etiology.

A study of Table iv giving the percent-

TABLE II

PERCENTAGE OF RECTAL CASES, PERCENTAGE OF STRICTURE CASES, RACE PERCENTAGE, AND SEX PERCENTAGE,  
113 CASES OF STRICTURE OF THE RECTUM

Note: 47 Cases of Stricture from Jefferson Davis Hospital Prior to 1928 Not Given in This Chart

Origin of Material	Number of Rectal Cases	Race	Race Per Cent of Rectal Cases	Number and Per Cent of Stricture Cases	Race Per Cent of Stricture Cases	Sex Per Cent of Stricture Cases Race Segregated		Total Sex Per Cent of Stricture Cases	
						Male	Female	Male	Female
Hermann Hospital Clinic 1926, 1927, 1928, 1929, 1930	357	White	196 or 54.9	45 or 12.60	6 or 13.33	1 or 2.22	5 or 11.11	3 or 6.66	42 or 93.33
		Colored	161 or 45.09		39 or 86.66	2 or 4.44	37 or 82.22		
Jefferson Davis Hospital Clinic 1928, 1929, 1930	939	White	342 or 36.42	50 or 5.32	2 or 4	1 or 2	1 or 2	7 or 14	43 or 86
		Colored	546 or 58.14		46 or 92	5 or 10	41 or 82		
		Mexican	51 or 5.43		2 or 4	1 or 2	1 or 2		
Private Practice 1927, 1928, 1929, 1930	1451	White	1432 or 91.79	18 or 1.25	13 or 72.22	7 or 38.88	6 or 33.33	9 or 50	9 or 50
		Colored	19 or 1.30		5 or 27.77	2 or 11.11	3 or 16.66		
Total	2747	White	1970 or 71.71	113 or 4.11	21 or 18.58	9 or 7.96	12 or 10.61	19 or 16.81	94 or 83.18
		Colored	726 or 26.42		90 or 79.64	9 or 7.96	81 or 71.68		
		Mexican	51 or 1.88		2 or 1.76	1 or .88	1 or .88		

ages, because this is the most active age sexually and more venereal diseases are contracted at this time than any other.

I believe that in some cases of stricture of the rectum fistulae, rectal abscesses, fissures, and such pathology are the etiological factors. Infection passes up the lymph channels or invades the mucosa and submucosa, with resulting inflammation. I feel reasonably sure that in two of the cases I had, this was the cause of the stricture. Tuberculosis has been assigned very frequently as the cause and congenital strictures occur occasionally. Malignant strictures will not be considered in this discussion. I will take up the classification of the 160 strictures of the rectum

age of smears is quite interesting. Of the 78 smears made, 54 or 69.23 per cent were positive and 24 or 30.76 per cent were negative. There were 82 cases on which no smears were made. In the subchart showing the analysis of these 78 smears, you can see what a high percentage of positive reactions the females had, especially the colored females. In making these tests, one should not be satisfied with one negative smear but should make repeated smears, because the mixed bacterial flora often obscures the gonococci and I think that very often this mixed flora kills out the gonococci and you have only the mixed bacteria left.

In Table v, we have an analysis of Wassermann reactions. There were 103

Wassermann tests made, with 71 or 68.93 per cent positive, and 32 or 31.06 per cent negative. The remaining 57 had no

this. Syphilis might play some part in the formation of stricture, but it would seem to me from the study of the smear and

TABLE III

SEX		RACE	
	(Per Cent)		(Per Cent)
Male.....	25 (15.82)	White.....	25 (16.02)
Female.....	133 (84.17)	Colored.....	126 (80.77)
Not given.....	2	Mexican.....	5 (3.20)
		Not given.....	4

160 CASES

Sex.....	White (Per Cent)	Colored (Per Cent)	Mexican (Per Cent)	Race Not Given (Per Cent)
Male.....	13 (8.12)	10 (6.25)	1 (.62)	1 (.62)
Female.....	12 (7.50)	116 (72.50)	4 (2.50)	1 (.62)
Sex not given.....	.....	.....	.....	2 (1.25)
Total.....	25 (15.62)	126 (78.75)	5 (3.12)	4 (2.50)

AGE INCIDENCE

1 mo. to 1 yr.....	2
1 yr. to 10 yrs.....	0
11 yrs. to 20 yrs.....	2
21 yrs. to 30 yrs.....	66
31 yrs. to 40 yrs.....	53
41 yrs. to 50 yrs.....	12
51 yrs. to 60 yrs.....	7
61 yrs. to 70 yrs.....	6
71 yrs. to 80 yrs.....	1
Not given.....	11

Wassermann tests taken. The proportion of positive Wassermann tests in the races seems to be about the same, and about the same in both male and female, yet there is no increase in the number of strictures in the colored male because of

Wassermann charts on these cases that there is evidently some other factor much more important than syphilis, and I believe that this is gonorrhea. Negro men have syphilis about as often as negro women and if syphilis were the chief

etiological factor, it seems that the negro men would have strictures as often as the negro women. Twenty-nine of these

the smears which anyone who is interested can study at his leisure.  
Symptoms of stricture of the rectum

TABLE IV  
SMEAR

	(Per Cent)
Positive.....	54 (69.23)
Negative.....	24 (30.76)
Not taken.....	82

ANALYSIS OF 78 SMEARS MADE

Race	Male		Female		Total	
	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)
White.....	2 (2.56)	1 (1.28)	3 (3.84)	2 (2.56)	5 (6.41)	3 (3.84)
Colored.....	1 (1.28)	3 (3.84)	47 (60.25)	16 (20.51)	48 (61.53)	19 (24.35)
Mexican.....	.....	1 (1.28)	1 (1.28)	1 (1.28)	1 (1.28)	2 (2.56)
Total.....	3 (3.84)	5 (6.41)	51 (65.38)	19 (24.35)	54 (69.23)	24 (30.76)

TABLE V  
WASSERMANN TEST

	(Per Cent)
Positive.....	71 (68.93)
Negative.....	32 (31.06)
Not taken.....	57

ANALYSIS OF 103 WASSERMANN TESTS MADE

Race	Male		Female		Total	
	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)	Positive (Per Cent)	Negative (Per Cent)
White.....	4 (3.88)	2 (1.94)	3 (2.91)	3 (2.91)	7 (6.79)	5 (4.85)
Colored.....	4 (3.88)	3 (2.91)	58 (56.31)	23 (22.33)	62 (60.19)	26 (25.24)
Mexican.....	1 (.97)	.....	1 (.97)	1 (.97)	2 (1.94)	1 (.97)
Total.....	9 (8.73)	5 (4.85)	62 (60.19)	27 (26.21)	71 (68.93)	32 (31.06)

cases had positive Wassermann reactions and positive smears. I have a chart on the comparison of the Wassermann tests and

are straining at stool, passing of pus and blood, and marked constipation or incontinence, many not being able to have a

stool without taking medicine to make it liquid. The incontinence is from the fact that you have a tube-like stricture which probably involves the anal canal and there is no contractility left in the anal muscles. There is frequently a great deal of pain from fissures or ulcers in the anal canal. If the condition has been present for a long time, there are the accompanying symptoms of obstruction, such as the formation of large amounts of gas, colic-like pains in the abdomen, and indigestion.

The diagnosis is easily made by proctoscopic examination, digital examination, or x-ray. It is not often necessary to do a biopsy. A study of the pathology in this condition is not very illuminating as to the cause of the stricture. The following is a typical pathological report from a section of tissue examined: "Section from rectum with markedly thickened walls, showing hard fibrous tissue formation throughout. There is rather marked round cell infiltration. Mucous membrane is absent. Diagnosis: Inflammatory stricture of the tectum." I have had many sections examined, but the pathologists have never been able to give any definite information on the etiological factor. They were not able to tell whether the tissue was leutic or not and they have never given me a report stating that it was tuberculous.

In the classification in Table VI of the 160 cases, I have reported 147 cases of inflammatory stricture and have not included tuberculosis in these. I did not classify syphilitic strictures as a separate type of stricture, because I do not believe that syphilis plays a very important part in the causation; I think it is more coincidental rather than causative. Under these inflammatory strictures, you will note again the preponderance of the occurrence of strictures in the female colored, and under the concentrated chart marked "Smears for Gonorrhea" that in the 74 cases on which there were no smears, there was a history of pelvic infection in 33.

I have listed 3 cases as tuberculous, but am not certain that they were tuberculous, because I did not find tubercle bacilli and could not tell from the tissue involved. However, these 3 cases had a persistent diarrhea of almost nothing but pus and blood and one had many constrictions throughout the bowel, which we felt were tuberculous.

Of the 6 postoperative strictures, 5 were in white people and 1 was in a colored male. I have put in this list, 1 case that might have been classed as inflammatory. This particular case was the result of injection treatment for hemorrhoids and is the only case of stricture of the rectum that I have ever seen following this mode of treatment. I did not give the patient the injections, but saw him after the stricture had begun to form and communicated with this former doctor, who told me that the patient did not have a stricture when he first started treatment.

Two cases were congenital strictures, one being in a male infant and the other in a female infant. These children were born with openings that would only admit a probe to the anus.

There was 1 case of perirectal stricture in a colored man, resulting from a periprostatic abscess which circled the rectum. The rectal mucosa was not involved. I believe that this type of stricture is extremely rare. I had the privilege of seeing this man when he had the periprostatic abscess and watched this condition form. The pus almost circled the rectum and formed fistulae in the perineum.

There was one case of true spasmodic stricture in a white male, a young man who had a small anal fistula which passed up the mucosa of the rectum. He had a great deal of pain in the sacral region. The spasmodic stricture was about 3 in. up the rectum and had been present so long that a great deal of fibrous tissue had formed. After the fistula had been dissected up to this spasmodic structure and followed by a year's treatment of massage

and frequent rectal lavages, this stricture gradually gave way.

Some men have suggested that strictures are caused by chronic pelvic inflammation with infiltration of the perirectal lymphatics. I believe that this is very rare and that the development begins in the mucosa of the rectum, with ulceration and infection, and scar formation in the mucosa and submucosa finally involving the entire wall of the rectum and some of the perirectal tissues. I do not believe it is necessary to classify these strictures as annular or tubular, because with the exception of some of the anal strictures resulting from operations, most of the rectal strictures become tubular in time. They usually have an annular ring at some place in the canal, but there will develop a tubular stricture above or below this ring as time goes on. This ring might form at the levator margin or at one of the rectal valves, but it is only part of the general strictured condition of the rectum.

I have noted that in the cases of stricture in the negro women there is nearly always an active ulcerating process present, with condylomata in some parts of the anal canal and especially where there is an annular ring. Very frequently there is a rectovaginal fistula. I do not have a list of the cases in which this has occurred, but it is extremely frequent. It seems that you would get a fistulous tract above the stricture, but such is rarely the case. Most of the fistulous tracts occur below the annular ring, and when one is present, it usually passes through the perineal body. This must be because of the spasmodic contraction of the anal muscles, and the retention of infected material between the annular ring and these muscles.

Complications of these strictures are abscesses, fistulae, upper intestinal troubles, loss of weight, and what might also be mentioned, a persistent infection in the rectum. There are so many pockets that at times it seems almost impossible to rid the rectum of infection. I have seen rheumatism in several cases and had one

TABLE VI  
160 CASES OF STRICTURE OF THE RECTUM

Classification	Race and Sex										Wassermann Test		Smears for Gonorrhea				Treatment					Fistulotomy Fissurectomy Hemorrhoidectomy Plastic on Rectum, Etc.		
	White		Colored	Mexican	Not Given		Positive		Negative	Not Taken	Hist. of G. C.		No Hist. of G. C.	History of Pelvic Infection	No History of Pelvic Infection	Colostomy	Excision	Proctotomy and Incision	Dilatation	Local Treatment				
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female				
Inflammatory (except tuberculous).....	8	7	8	115	1	4	1	1	1	2	69	29	49	53	9	11	33	41	29	4	24	16	69	5
Tuberculous.....	3	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	2	
Postoperative.....	6	2	3	1	1	1	1	1	1	1	1	2	4	1	1	1	1	4	1	1	1	1	3	
Congenital.....	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	
Perirectal.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Spasmodic.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total.....	160	13	12	10	116	1	4	1	1	2	71	32	57	54	11	13	33	49	31	4	25	17	75	8

TABLE VII  
COMPARISON OF WASSERMANN REACTIONS AND SMEARS

Race	Sex	Positive Wassermann Reaction with Positive Smear	Negative Wassermann Reaction with Positive Smear	Wassermann Not Taken with Positive Smear	Positive Wassermann Reaction with Negative Smear		Negative Wassermann Reaction with Negative Smear		Wassermann Reaction Taken with Negative Smear		Positive Wassermann Reaction with No Smear		Negative Wassermann Reaction with No Smear		No Wassermann Reaction with No Smear	
					History	No History	History	No History	History	No History	History	No History	History	No History	History	No History
					Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection	Indicative of Gonorrheal Infection
White	Male	1	..	1	..	1	..	..	..	..	1	1	..	2	1	5
	Female	1	1	1	1	..	1	..	1	..	..	2	..	1	..	4
Colored	Male	1	..	..	..	..	1	2	..	..	2	1	1	1	..	1
	Female	26	11	10	1	6	1	4	..	..	11	10	4	3	12	13
Mexican	Male	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
	Female	..	1	..	..	1	..	..	..	..	..	..	..	..	1	1
Not Given	Male	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	Female	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Total	Not Given	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
	.....	29	13	12	3	8	3	4	2	1	14	14	5	7	14	28

case in which it was so bad that I did an excision. The patient was relieved of the rheumatism, but still had an infection of gonorrhea in the rectal stump.

The treatment of stricture of the rectum, in my hands, has been very unsatisfactory. If these cases are not an emergency when they are seen in the clinic, they are routinely given some kind of an antiseptic with which to irrigate their rectum and the stricture is dilated with the finger if possible. This manner of treatment is maintained as long as possible, in order to help clear up the infection. I do not remember having seen a single case in the clinics that did not have a great deal of infection; however, in private practice, I have seen several that would have been classed as clean cases and these were in white people. If the stricture is so severe that the straining and passing of pus and blood are very marked, we send them into the hospital and under a spinal anesthetic, dilate or incise the stricture. If it is close enough to the anal margin, we do a proctotomy. I have done a proctotomy and incision in 25 cases and simple manual dilation under anesthesia in 17. We then have the patients keep up the rectal irrigations and continue coming to the clinic for dilations.

Clemons<sup>4</sup> recommends the use of carbon dioxide snow and other men have recommended the use of diathermy. I have never used diathermy and have used carbon dioxide on only 1 case. This was a white male with a clean stricture and I believe the result was very beneficial. Unfortunately, it takes a great deal of time to administer these treatments. Clemons does not recommend the use of carbon dioxide where there is a great deal of infection in the rectum and it seems almost impossible to clear up the infection in these inflammatory conditions.

Irrigations, dilations, and a proctotomy will often tide these patients along for several years, but in many we have to do a colostomy. Of this series reported there were 31 colostomies performed. After this

is done, the patient can irrigate the bowel from above, down, and this usually gets rid of a great deal of infection. However, we have seemingly never been able to get the bowel entirely free of infection. I had some trouble with the retraction of the colostomy wound in a number of the first patients who were operated upon. This was because of the weak musculature of the abdominal wall, especially in women who had had several babies. Hence, I have adopted the type of colostomy in these particular cases in which all layers are sewed through a large rent in the mesentery under the loop of bowel, and the bowel is not severed entirely when it is opened. This prevents the bowel from retracting and keeps an absolutely clean wound after the operation, as cathartics can be given several times and the bowels cleaned out, and it is not necessary to open the colostomy for eight or ten days. I believe that in the future, I shall resort to excision after the colostomy more often, if the condition of the patient warrants. I think it will be warranted in those cases where the general condition of the patient continues to be bad and the absorption of infection from the diseased bowel seems to be the cause.

It seems to me that excision of the rectum is not resorted to soon enough in these cases. I have done excisions in 4 cases after a colostomy had been performed. In one of these, there was a great deal of infection, with much pus and the patient did not improve as she should have done after the colostomy was performed. In another, rheumatism was very bad. Three of these patients improved markedly after the rectum was removed, but in one, a negro woman who had active gonorrhea, tertiary syphilis, and pulmonary tuberculosis, there was no improvement. Her tuberculosis developed several months after the excision and she died in about one year after the operation.

It is gratifying to see how the general condition of these patients improves after a colostomy. However, many refuse a



colostomy and hence, we lose sight of them. I have had only 1 case in which I was able to close the colostomy. This was a negro woman about fifty years old, whose colostomy we closed after the rectum had become fairly clean and in good condition under irrigations and manual dilations. She has been doing well for about three years. In those patients having syphilis, antiluetic treatment did not stop the development of the stricture or improve the condition in any way. I think, however, it does improve the general health of the patient.

#### CONCLUSION

I would conclude from the study of these cases that nearly all strictures of the

rectum are inflammatory; that gonorrhea, in the colored race at least, is the chief etiological factor; and that they occur much more frequently in colored women than in any other race or sex.

I believe that the scar-forming tendency of the colored race is the real basis of the stricture formation in this race.

There is only a slight tendency to stricture formation in the white and Mexican races.

Syphilis seems to play a very unimportant part in the formation of stricture of the rectum.

As yet, treatment is very unsatisfactory and we feel that excision should be resorted to in the badly infected cases more often than it is at present.

#### BIBLIOGRAPHY

1. ASHHURST, A. P. C. Stricture of rectum; resection. *Surg. Clin. North America*, 2: 63, 1922.
2. BARBILIAN, N. Quelques considerations sur le traitement des retrecissements inflammatoires du rectum. *Presse méd.*, 33: 286, 1925.
3. BIRT, E. Gutartige Strikturen des Rektums. *Arch. f. Schiffs- u. Tropen-Hyg.*, 33: 1, 1929.
4. CLEMONS, E. J. (a) Rectal stricture and rectal cancer treated with carbon dioxide snow. *Med. Rec.*, 101: 364, 1922.  
(b) An original treatment for rectal stricture. *Tr. Am. Proct. Soc.*, 81: 82, 1924.  
(c) Rectal stricture; a method of treatment with demonstration. *Tr. Am. Proct. Soc.*, 1926.
5. DAY, G. H. Urological idiosyncrasies of the negro. *J. Urol.*, 5: 19, 1921.
6. DEROCHE, J. Contribution a l'étude des retrecissements inflammatoires du rectum. Paris Thesis, 1925, vol. 18.
7. DESPLAS, B., and SAVIGNAC, R. Un cas d'amputation du rectum pour stenose dite inflammatoire. *Arch. d. mal. de l'app. digestif.*, 17: 432, 1927.
8. GORASH, B. A. Gonorrhea of rectum. *Brit. J. Ven. Dis.*, 4: 74, 1928.
9. HAYES, H. T. Gonorrhea of the anus and rectum; report of seventy-five cases. *J. A. M. A.*, 93: 1878-1880, 1929.
10. HEITZ-BOYER, M. Retrecissements et polypes du rectum traité par la haute fréquence. *Bull. et mem. Soc. de chir. de Paris*, 48: 1045, 1922.
11. JOACHIMOVITZ, R. Rectumstrikturen bei gynakologischen Erkrankungen. *Deutsche Ztschr. f. Chir.*, 208: 263, 1928.
12. KUMMER, R. H. Le traitement du retrecissement du rectum par la diathermie. *Schweiz. med. Wchnschr.*, 58: 643, 1928.
13. LEVY, A. Traitement des retrecissements inflammatoires du rectum par la diathermie. Paris Thesis, 1926, vol. 46.
14. MINOR, W. E. Clinical Proctology. St. Louis, Mosby, 1929.
15. PAPPO, I. H. A propos d'une brulure du rectum; le traitement diathermique des retrecissements du rectum. Paris Thesis, 1927, vol. 53.
16. PARNELL, R. J. G. Venereal lesions of the rectum and anus. *J. Roy. Nav. Med. Serv.*, 15: 77, 1929.
17. ROSSER, C. (a) Proctologic peculiarities of the negro; the fibroplastic diathesis. *AM. J. SURG.*, 37: 265, 1923.  
(b) Stricture of the rectum. *Texas State J. Med.*, 9: 508, 1924.  
(c) Rectal pathology in the negro; incidence and peculiarities. *J. A. M. A.*, 84-93: 96, 1925.  
(d) Clinical variations in negro proctology; the venereal factor. Sec. on Gastro-Enterology and Proctology, *A. M. A.*, April, 1926.
18. SAVIGNAC, R. A propos des rectites chroniques hypertrophiques et stenosantes. *Arch. d. mal de l'app. digest.*, 15: 269, 1925.
19. SMITAL, W. Beitrag zur Klinik der entzündlichen Rektalerkrankungen und ihrer Folgeerscheinungen. *Deutsch. Ztschr. f. Chir.*, 170: 318, 1922.
20. SMITH, D. New treatment for rectal stricture. *California & West. Med.*, 24: 782, 1926.
21. VIGNAL, W. La diathermotherapie des retrecissements inflammatoires et cicatriciels du rectum. *Bull. et mem. Soc. de chir. de Paris*, 20: 14, 1928.



# NEW INSTRUMENTS

## AN IMPROVED HEMOSTATIC FORCEPS\*

ROBERT L. PAYNE, M.D.

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IN the same sense that a chain is no stronger than its weakest link we can conclude that every one of the present

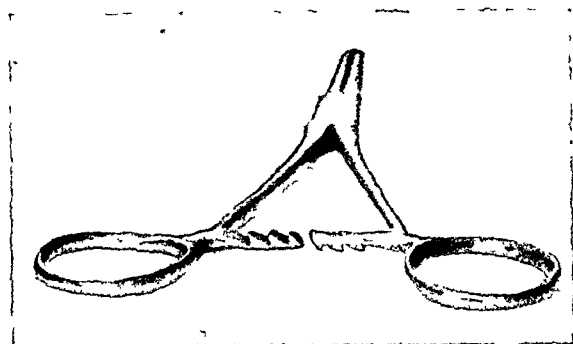


FIG. 1.

types of hemostats now on the market are no stronger than their weakest point, which is the presence of a single ratchet catch on only one shank of the instrument. No matter how sturdy the clamp may be built from every other perfection in manufacture when this one ratchet catch wears down then the life of the clamp is gone and its holding quality is nil.

The clamp herein illustrated is provided with three ratchet catches on each shank of the instrument. This improved feature provides for two factors in the usefulness of the clamp that does not obtain in any other hemostatic forcep on the present day market. First, this clamp has three times the holding strength when applied to pedicles for a short or long time because there are three catches on both shanks holding at the same time and thus minimizing the danger of the clamp coming loose. It has been the custom, when clamps were left on pedicles for a long number of hours, to tie the handles

together with strong linen lest the clamp should become loosened. This danger is entirely overcome through the arrangement of this improved clamp. Secondly, the economic feature, namely, that this clamp will last just three times as long as the hemostats now on the market. I am informed by expert mechanical engineers that all three ratchet catches on this clamp will not wear uniformly, therefore making the life of the clamp indeterminately long. To support this argument I used a dozen of these clamps continuously for three years at which time the ratchet catches were still holding but they were discarded because the teeth on the jaws had rusted and worn away.

For a period of about twelve years I have sought to get some manufacturer to turn out this style of clamp and in each instance the suggestion was laughed down, presumably because of the durability and lasting quality of this triple ratchet forcep which would necessarily minimize the total sale of hemostatic forceps by the manufacturer. I am glad to say a reputable manufacturer has been sufficiently broad minded to recognize the value and money saving feature to the profession of this clamp and has finally consented to manufacture it for sale at a reasonable price.

The principle can be utilized in making up any style, type or weight of hemostatic forcep. Because this three ratchet catch represents such an economic saving to the profession, by virtue of the long life of the instrument, I have persisted for so many years in my effort to get this improved clamp available to the profession.

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## EDITORIALS

### SPINAL ANESTHESIA

IN a recent survey of the department of anesthesia of forty-one hospitals located in widely distributed sections of this country there were correlated 20,185 cases in which spinal anesthesia has been used. From a careful study and review of these spinal anesthesia cases it would seem that sane conclusions can be chosen as to the real value today of this form of anesthesia in surgery.

Of the 20,185 spinal anesthetics, 19,324 were a complete success in so far as producing the desired anesthetic results necessary for the successful completion of the operation in question.

Of the 20,185 cases cited it was reported that in 861 instances this form of anesthesia was not satisfactory. In other words in this number of cases either no anesthetic

influence resulted or it was not complete enough to proceed with the operation or the anesthetic influence disappeared in too short a time for the operation to be completed. Where anesthesia had been produced the time of its disappearance varied from fifteen to forty minutes. Thus in one in every 23 cases or 4.3 per cent of the cases the anesthetic influence was either not produced at all or when it was produced it was in some instances only partial while in others it was of short duration.

In this series of collected cases there were reported thirty deaths directly attributable to the spinal injection. This shows a death rate of one in every 672 cases. No cases were reported that the death did not occur within a short time of the spinal injection.

As regards any reactionary or untoward signs or symptoms occurring following spinal injection it was reported that they took place in one form or another in about 90 per cent of the 20,185 cases.

These reactionary or untoward signs and symptoms varied very much in type as well as in severity. Nausea and vomiting were the leading reactions, closely followed in a number of occurrences by lowering of the blood pressure and by some form of respiratory collapse. These four reactionary phenomena occurred in one case or another in about 90 per cent of the cases.

A rather large percentage of the patients attained a state of very free perspiration which appeared in large beads over the face, neck, chest and upper extremities. Headache, of the occipital type, was a very frequent complaint as a subjective symptom. In not a few cases this headache would persist for 24 to 48 hours.

Nervous excitement was another symptom which was present in 10 to 20 per cent of the cases. In one case it was reported that this condition became so extreme that the patient had to be placed in a restraining sheet. This patient however fully recovered after a few hours.

Pallor was a sign which showed itself in a very large percentage of the cases and extreme pallor was reported as being present in over half of the cases.

Subjective weakness was complained of in about 40 per cent of the cases, which passed away in from one to three hours.

A tight feeling about the chest and also dizziness were complained of in from 10 to 15 per cent of the cases. In a few of the reported cases incontinence of feces was reported. A sudden rise of temperature of from 1 to 3° was also reported as having occurred in a few instances.

About 5 per cent of the patients were reported as having complained of pain in one or both of the lower extremities. This pain was rather dull in character, continuous, and involving in some instances the thighs and in others the calf of the leg. In 3 cases a sharp, piercing pain, rather fleeting in character, was

reported as present in the lower abdomen.

One anesthetist reported that he found by giving oxygen slowly but continuously through a face mask that many of these untoward signs and symptoms were either entirely eliminated or very materially ameliorated. He found that by thus continuously administering oxygen, nausea, vomiting, lowering of blood pressure, respiratory phenomena, etc. were in all instances much modified and in not a few cases entirely eliminated.

Two large hospitals reported that none of their surgeons would use spinal anesthesia as they considered it unsafe.

It would appear from this review of a workable number of spinal anesthesia cases that, compared to a general anesthetic such as ether or gas oxygen or a combination of the two, all things considered, a general anesthetic is more dependable and carries with it a very much lower death rate. The same can be said regarding local analgesia, nerve block or spinal root nerve block.

However, it surely can be stated that there are cases where spinal anesthesia is especially indicated, as for instance in patients who have diabetes or a similar disease or conditions where a general anesthetic is contraindicated.

In time a greater experience and wider field of usefulness may and probably will produce a much greater degree of safety in the use of spinal anesthesia. However its usefulness must always remain limited to the extent that some areas demanding operative interference such as the heart, lungs, neck, head, throat, etc. must be done under the influence of an anesthetic of another type.

In emergency war surgery it would seem as if spinal anesthesia must always have its limitations in comparison with other forms. Nevertheless spinal anesthesia appears to be serving well in a very large number of cases and as previously stated no doubt further and wider experience may prove it to be more indispensable than would seem at the present time.

GEORGE S. FOSTER, M.D.



## AMERICAN PHYSICIANS

SAMUEL BARD

**S**AMUEL BARD, son of the physician John B. Bard who was the first one to report a case of extra-uterine pregnancy in America, was born in Philadelphia, April 1, 1742. When he was four years of age the family moved to New York.

When fourteen years old, Samuel entered King's College. In the fall of 1760 he sailed for Europe but was captured by a French privateer and taken to Bayonne where he was confined in the castle. Once he was released he proceeded to London. Recommended by Dr. Fothergill, he was appointed to St. Thomas' Hospital as assistant to Dr. Alexander Russell. Next he went to Edinburgh, graduating in 1765, with great honors.

Dr. Bard returned to New York and began practice with his father. In 1770 he married his cousin, Mary Bard.

Samuel had written his father from abroad that New York should have a medical college. After three years in New York he gained the cooperation of several physicians and in 1768 the school was opened and united to King's College. Bard became professor of the theory and practice of physic. He was twenty-eight years old, the youngest man on the faculty.

Bard was loyal to the Crown and when hostilities began in 1776 he moved to Shrewsbury, N. J. When the British captured and occupied New York Bard returned. He built a large and lucrative practice and soon became rich. Perhaps he remembered Fothergill's words: "I crept over the backs of the poor into the pockets of the rich." After Washington

was inaugurated and made New York his headquarters, Bard became his family physician.

Doctor Bard became Dean of the Faculty. He was largely instrumental in the establishment of "The Society of the Hospital of the City of New York in America," in the establishment of the city library, and of the New York Dispensary. He retired from practice in 1798.

In 1811 he was elected an associate fellow of the College of Physicians of Philadelphia. In 1816 the degree of Doctor of Laws was conferred upon him by Princeton College.

In 1771 he published "An Inquiry into the Nature, Cause and Cure of Throat Distemper, as it is called by the Inhabitants of this City and Colony." Having been one of the busiest accoucheurs of his day and vitally interested in the subject, during his days of retirement he wrote for midwives and young practitioners, "A Compendium of the Theory and Practice of Midwifery." He was working on the 6th edition when he died. In 1811 he published "A Guide to Young Shepherds," which for years was considered one of the best authorities on sheep breeding. Several fugitive essays by Bard are preserved in the *American Medical and Philosophical Register*, and *The Transactions of the College of Physicians of Philadelphia* contain several of his papers on yellow fever. In 1819 he wrote "A Discourse on Medical Education."

Samuel Bard died at Hyde Park, N. Y., on May 25, 1821, in his ninetieth year.

T. S. W.



SAMUEL BARD

[1742-1821]

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BIOGRAPHICAL BREVITIES  
"American Physicians"

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[From Fernelius' *Universa Medicina*, Geneva, 1679.]

# BOOKSHELF BROWSING

CONTRIBUTIONS OF ANIMAL EXPERIMENTATION TO MEDICAL PROGRESS

## ENDOCRINOLOGY\*

J. M. ROGOFF, M.D.

CLEVELAND, O.

IT is not surprising that as physics and chemistry became more intimately associated with biology, permitting more fundamental observations to be made on the processes of life, medical progress was influenced so greatly that it advanced much more rapidly within the past three centuries than in all preceding periods. The greatest progress in the prevention and cure of disease has been made during the past fifty to one-hundred years. In the beginning of the second half of the nineteenth century the foundation for modern experimental medicine was laid by the eminent physiologist, Claude Bernard. The use of anesthetics in surgical procedures had been recently introduced and was advancing. This made possible the use of animals for experimental investigations, under humane conditions, and gave rise to valuable research in all fields of biological science.

Bernard's investigations on the glyco-genic function of the liver, the studies by his pupil, Brown-Sequard in 1856, on the effects of removal of the adrenal glands, and the pioneer experiments in the same

period, by Moritz Schiff, on the thyroid gland were the beginnings of our present knowledge in endocrinology. Thus, this subject is a direct outgrowth of experimental medicine.

Various conceptions of the process of internal secretion have prevailed since about the middle of the 18th century. The modern idea of this process, however, is founded upon Bernard's demonstration of the elaboration, storage and use of liver-glycogen and the statement of his belief that other organs like the thyroid, suprarenals and spleen furnish an internal secretion. A definite relationship between certain diseases and the disturbed functions of various organs known or believed to furnish essential internal secretions, was established through the correlation of physiological experimentation upon animals, clinical observation, and pathological examination. The relation of certain morbid changes in the adrenal glands to the syndrome known as Addison's disease was described in 1855; and later the importance of certain endocrine organs was demonstrated by observations on the relations

\* This is the fourth of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.



of the thyroid gland to myxoedema and cretinism, of the pituitary to acromegaly and other conditions, and of the pancreas to diabetes. A number of other diseases are known to be associated with abnormalities in structure or function of certain organs or glands believed to furnish internal secretions.

The group of organs known as the *endocrine glands* includes the adrenal, thyroid, parathyroid, thymus, pituitary, pineal, pancreas, liver, spleen and the gonads or sex glands. Nearly all of these organs have been known to anatomists for a long time. Yet their functions have remained a complete mystery prior to the advent of modern experimental medicine. They have been generally classed as the ductless glands inasmuch as the specific active substances, or "hormones," which they elaborate are discharged directly into the blood or lymph which passes through the organs. This distinguishes their *internal* secretions from external secretions, which are discharged upon a surface or into channels and carried away from the cells or organs that produce them. In a broader sense the term *internal secretion* has been used to include products of the metabolism of cells in organs or tissues other than the glands above mentioned, but for the present purpose we shall limit the use of this term to the products of these glands.

For the prevention and cure of disease we need an understanding of the immediate and remote causes which underly disturbances of normal processes. Systematic clinical studies and post mortem examinations yield valuable information on the relation of special organs to certain diseases; but a diseased condition can be satisfactorily understood and corrected only when the normal physiological processes of the organs in question are known. In the case of the endocrine glands, their functional significance is generally investigated experimentally by creating a deficiency of function through surgical removal or destruction of the organs. The resulting condition is studied and compared with

conditions that are known clinically to be associated with disorders of such organs. Correction of the deficiency is then undertaken by attempting to compensate for the loss of the glands. This is sometimes accomplished by feeding desiccated gland products, by transplantation, or by administration of extracts of the gland. Where active products of endocrine glands have been obtained it has been possible not only to study and correct deficiencies but to learn the relation of excessive function to certain maladies. Ultimately, the isolation, from an endocrine gland, of a specific *hormone*, its identification, and knowledge concerning its elaboration, storage and secretion by the gland, lead to a clearer understanding of normal function and to the correction or prevention of abnormal conditions of the organ.

#### INSULIN

The experiments of von Mering and Minkowski, in 1889, strikingly demonstrated an intimate relationship between the pancreas and carbohydrate metabolism. They discovered that animals from which the pancreas had been removed developed a diabetic condition. This suggested the existence of an internal secretion, from this organ, having an important influence upon metabolism of sugar. Numerous attempts to isolate the active product of this secretion followed, some of them with a measure of success. Extracts prepared from the glands were found to be capable of exerting a favorable influence upon the hyperglycemia and glycosuria which followed surgical extirpation of the pancreas, in laboratory animals. Numerous experiments on animals by various investigators contributed substantially to our further knowledge until insulin was successfully prepared. The final steps were elaborated by a group of investigators working under the direction of Macleod. Banting and Best prepared extracts of pancreas, after destruction of the alveolar tissue by ligating the duct of Wirsung, leaving the insular tissue. Thus the destructive action

of the digestive enzymes of the gland was avoided, and preparations of high potency were obtained. Collip purified the preparations by fractional precipitation of the extracts, with alcohol, rendering them suitable for parenteral administration in human beings.

Space will not permit consideration of all the endocrine organs, nor of detailed discussion of much of the experimental work concerning any of them. An analysis of the experimental studies on the adrenal glands and a brief review of some of the outstanding experimental work on the thyroid will suffice to illustrate the method and the results in this field.

#### THE ADRENAL GLANDS (SUPRARENAL CAPSULES)

The adrenal glands are indispensable for life. Failure of their function leads to a fatal malady, Addison's disease. They were the first of the endocrine organs for which a relationship was demonstrated between disturbed function and a certain definite disease. A number of valuable contributions have resulted from studies concerning the adrenals, and important investigations are in progress. Indispensability of the "suprarenal capsules" for life and health was established by Thomas Addison in 1855. While engaged in a study of certain types of anemia, he observed a number of cases which clinically resembled primary anemia, yet differed sufficiently to enable him to classify them as manifestations of a definite syndrome, associated with disease of the suprarenal capsules. He described 11 cases in which he found certain characteristic symptoms and which all terminated in death within a relatively short time. Post-mortem examination revealed disease or destruction of the suprarenal glands. Chief among the symptoms were profound muscular and cardiovascular asthenia, gastrointestinal disturbances, and development of a characteristic pigmentation of the skin. This condition, known as Addison's disease, is not frequently encountered but if always recognized would unquestionably be found

to exist less rarely than has hitherto been supposed.

Although it is three-quarters of a century since this disease was clearly recognized, and a considerable number of cases have been carefully studied, clinically and pathologically, very little has been added to our knowledge of the syndrome, and its treatment has hitherto been unsuccessful. Recently, however, experimental studies on adrenal insufficiency, conducted by the writer in collaboration with G. N. Stewart, have thrown some light upon the subject and have led to treatment of Addison's disease with encouraging and hopeful results. Addison's disease is but one manifestation of adrenal insufficiency and is the most severe one. Doubtless there exist less severe disturbances of adrenal function. But recognition of these conditions and successful treatment of them can be expected only when the normal function of the adrenal glands is more thoroughly understood.

The existence of these organs has been known for centuries. An accurate anatomical description of them was given by Eustachius in 1563. Various theories regarding the function of the adrenals have prevailed from time to time, based upon anatomical observations. These views illustrate how hopelessly investigators were compelled to grope in the dark, unaided by the light of modern experimental methods. Thus, the adrenal glands were supposed to "hold up the stomach and strengthen the nervous plexus which touches them." They were believed to collect the "humidities" which leak out of the large vessels in the neighborhood; or that within their cavities is preserved "black bile." "Some think they separate a Liquor from the Arterial Blood, for diluting the Blood, which is too thick after it comes from the Kidneys" (Lexicon Physico-Medicum; John Quincy, 1719).

Physiological investigations, upon animals, were begun by Brown-Sequard and followed by a number of other workers as soon as Addison demonstrated the relation

of the adrenals to the syndrome which bears his name. Attempts were made to create adrenal insufficiency, experimentally, in frogs, rats, cats, dogs, rabbits and guinea pigs, by surgical removal or destruction of the glands. The results obtained by most earlier and many recent investigators cannot be considered satisfactory, but they illustrate some of the great difficulties that must be overcome in experiments of this kind. The intimate anatomical relationship of the adrenal glands with important sympathetic nerve structures necessitates special skill and technique for their extirpation. Careful anesthesia and the strictest precautions of modern surgery must be exercised in the preparation of the animal, in the operation, and in the postoperative care.

Thus far, it has not been found possible to create, in animals, a condition identical with Addison's disease, although excision of the adrenals gives rise to symptoms commonly associated with that disease. But it has been thoroughly established that the glands are indispensable for life and health. This was indicated even by the results of some of the earlier and necessarily poorer operations for removal or destruction of the adrenals. Knowledge of the indispensability of the organs naturally led to the view that the adrenals either supply a substance which is essential for life or that they act by destroying certain harmful toxic substances which, in the absence of the glands, accumulate in the body.

#### ADRENALIN

In 1895, Oliver and Schaefer published results of experiments made to determine whether a physiologically potent product could be obtained from the adrenals. They made the very interesting observation that extracts, prepared from the glands, when injected into the circulation of animals, caused a remarkable elevation of the blood pressure. Further, it was found that this was a property of extracts made from the central portion, or medulla, of the gland.

Within a few years after this discovery the active substance, *adrenalin*, was isolated and prepared in pure form by Aldrich and by Takamine (1901). Demonstration of the presence of this product, in the gland, however, still left unsettled the question whether it represents an indispensable secretion or is the product of a detoxicating function, stored in the organ and later destroyed or slowly eliminated. It became necessary to determine whether this material is actually secreted from the gland, the rate of its secretion and whether the quantities ordinarily liberated are capable of exercising important physiological functions. The problem presented many difficulties, especially in the development of adequate quantitative methods for obtaining the essential information.

The availability of adrenalin, in pure form, led to extensive pharmacological studies and it soon found a place as one of the most useful therapeutic agents employed in medicine. Thus, its powerful influence in raising blood pressure, when injected into animals, demonstrated its usefulness in circulatory collapse and rendered it extremely valuable in combating shock. Indeed, this remarkable property of adrenalin suggested the theory that the function of its secretion by the adrenal glands is concerned with maintenance of normal blood pressure, hypersecretion resulting in excessive pressure and hyposecretion in low blood pressure. An important influence of the adrenal glands, in carbohydrate metabolism, has been suggested from the observation that adrenalin is capable of increasing the amount of sugar in the blood. The physiological actions of adrenalin have been determined, from studies upon various species of animals.

It has been found that the action of adrenalin upon organs that are innervated by sympathetic nerves is the same as the effect produced by electrical stimulation of these nerves. This "sympathomimetic" action of adrenalin, therefore, is capable of simulating certain reactions that are com-

monly associated with the responses to violent emotions. Upon some of the various effects following the administration of adrenalin there has been founded a theory of an "emergency function" of the adrenals, whereby the glands respond to major emotions by "outbursts" of the secretion. This theory, frequently accepted in modern teaching of psychology, and by some physiologists, is, of course, based upon the assumption that the adrenals are capable of liberating such quantities of adrenalin as are necessary to cause the above mentioned responses.

Various theories to explain the function of these glands are based largely upon pharmacological actions of adrenalin. We know, however, that physiological interpretations based on pharmacological reactions or on clinical observations alone too often lead to error. At the time that these theories were proposed no adequate methods for making quantitative studies upon the rate of epinephrin\* secretion from the adrenals, had yet been developed. The most satisfactory method that is now available for such studies is very laborious but has yielded consistent quantitative data on the ordinary rate of epinephrin secretion and on some of the conditions capable of modifying that rate.

The concentration of epinephrin in the normal systemic circulation is too low to permit its estimation by the most sensitive methods at present available. From the concentrations usually found in the adrenal vein blood it is estimated that the concentration in the general arterial blood cannot exceed about 1:1,000,000,000 to 1:2,000,000,000 under ordinary physiological conditions. To determine the rate of secretion of epinephrin from the adrenal glands it is necessary to know the rate at which blood flows from the glands and the concentration of epinephrin in that blood. The method for making these

measurements in an anesthetized animal consists of isolating a portion of the vena cava so that only the blood from the adrenal glands enter it. The blood is collected through this "cava pocket" and the quantity obtained in a known time is measured, permitting determination of the rate of blood flow from the organs. The epinephrin concentration in the adrenal blood is then determined by the aid of reactions upon segments of rabbits' intestine and uterus. This yields the necessary information for computing the rate of epinephrin secretion. The average rate, under ordinary experimental conditions, has been found to be very much less than the quantities employed in various pharmacological studies upon which certain theories of adrenal function have been founded.

In animals, anesthetized with either volatile (ether, chloroform) or non-volatile (urethane, chloretone) anesthetics, the average rate of epinephrin secretion, from the adrenal glands, has been determined at 0.000225 mgm. per minute per kgm. of body weight. It has been demonstrated that liberation of epinephrin is dependent upon the integrity of the nervous mechanism which governs the activity of the adrenal medulla. Thus, the secretion can be suppressed by interference with the nerve supply; it is augmented by stimulation of the splanchnic nerve; it can be abolished by transection of the spinal cord, in the upper dorsal region; and hemisection, in this region, suppresses the secretion from the adrenal on the same side as the cord section. Certain drugs (strychnine, nicotine, physostigmine) greatly increase the epinephrin output while other drugs (curara) depress it.

It has been found experimentally that epinephrin, secreted at the ordinary rate, can, under certain conditions, exert actions which may have functional significance; e.g. certain action upon the heart. From the regulation of the secretion, at a constant rate, through the nervous system it may be assumed that it exercises a physiological function. On the other hand,

\* The term *epinephrin* has been generally accepted to designate the physiological secretion from the medulla of the adrenal glands and to distinguish it from the commercial product, *adrenalin*.

it is not unlikely that the regulation is such that the rate of secretion is not high enough to produce harmful effects, but

embryonic structures, and in certain fishes they exist as two separate glands known as the *interrenal* and the *chromaffin bodies*.



FIG. 1A.



FIG. 1B.

FIG. 1. A, Animal comatose on fifth day following complete adrenalectomy. B, Recovery after intravenous injections of saline-dextrose solution. An injection was given daily and the animal survived, in good health, for over thirty-three days.

makes possible the gradual destruction or elimination of the epinephrin.

In any case, whatever the function of epinephrin may be, it is not the indispensable function of the adrenals. For it is possible to suppress, totally, the epinephrin secretion in an animal, by excision of one adrenal and denervation of the other gland. In addition, the medulla of the remaining gland can be destroyed. If a sufficient amount of the outer layer or cortex, of the gland has been left intact the animal will survive indefinitely, in excellent health. Unquestionably, the important function of the adrenals is not performed by the secretion of epinephrin but rests in the cortex or *interrenal* tissue of the glands. It is not surprising, however, that to epinephrin has been attributed the important function of the glands, since its secretion and the pharmacological effects of adrenalin were demonstrated at a time when very little was known about the cortex.

#### THE CORTEX OR INTERRENAL TISSUE

It is obvious that functionally the adrenal gland must be considered as consisting of two different glands. Anatomically, they are derived from different

In mammals, they become united in the course of development. Experimental evidence obtained within the past few years, and researches still in progress, in our laboratory, have demonstrated that disturbance or loss of function of the interrenal, and not that of the chromaffin tissue, is responsible for the syndrome known as Addison's disease.

If, under the most exacting surgical conditions, an animal is deprived of both adrenal glands it survives for only a relatively short time. Among certain animals (rats, rabbits) it is frequently found that removal of the adrenals does not lead to a fatal outcome. In such animals, it has been observed that there are present accessory adrenal bodies consisting of interrenal tissue: these suffice to sustain life in the absence of the adrenals. The symptoms which develop as the result of depriving an animal of its adrenals include loss of appetite, aversion to fatty food, gastrointestinal disorders (vomiting, often of bile), muscular weakness, circulatory disturbances and symptoms referable to the central nervous system (hallucinations, sometimes convulsions and coma). In addition, as these symptoms develop, exami-

nation of the blood reveals a marked increase in the total non-protein nitrogen, the urea nitrogen and the "undetermined" nitrogenous fraction. The percentage of sugar is usually below normal and in most cases there is concentration of the blood.

The condition indicates development of a very severe and rapidly fatal intoxication. For a number of days following adrenalectomy there is a period of good health, during which the animal is indistinguishable from normal animals. The symptoms develop about two or three days before death, rapidly increasing in severity. It has been demonstrated that the onset of symptoms can be postponed or, when already present, they can be relieved, and the life of the animal greatly prolonged, by intravenous injections of physiological salt solutions. This dilutes toxic material and facilitates its elimination. Similar beneficial influence is exerted by administration of certain extracts prepared by us from the cortex of adrenals. Such extracts compensate for the loss of the adrenals by supplying *Interrenalin*, the active principle or hormone of the interrenal or cortical tissue.

#### ADDISON'S DISEASE

Since 1915 extensive experimental studies upon animals have been in progress, at The Laboratory of Experimental Medicine of Western Reserve University, aiming to determine the physiological significance of the adrenal glands and their relationship to certain morbid conditions. The fundamental information obtained experimentally was applied, at the same time, in clinical studies upon Addison's disease. These studies have led to a different concept of the adrenal functional disturbances associated with the disease from that which had previously prevailed. Addison's disease was generally interpreted as a manifestation or result of insufficient epinephrin secretion. Some clinicians still adhere to this view and employ methods of treatment that include unsuccessful attempts to compensate for a supposed

lack of circulating epinephrin, by administering adrenalin. We have already pointed out that epinephrin secretion can



FIG. 2A.



FIGS. 2B AND 2C.

FIG. 2. A, Dog in excellent condition, thirty-two days after complete adrenalectomy, having received daily injections of adrenal cortical extract (*interrenalin*). B, Convulsions and coma (developed on the thirty-sixth day). C, Recovery following administration of Ringer's solution, in addition to the *interrenalin*. The animal survived forty-three days.

be suppressed without harmful results. The newer concepts, derived from the proof that the interrenal tissue is indispensable, are the basis of treatment employed by the writer; and this has thus far proven more beneficial in Addison's disease than any other treatment heretofore employed. It consists of administration of certain

preparations made from adrenal cortex with the object of supplying *interrenalin* and, in addition, intravenous administration of

(viz. gastrointestinal derangements, muscular and circulatory asthenia, nervous system disturbances) occur in both cases.

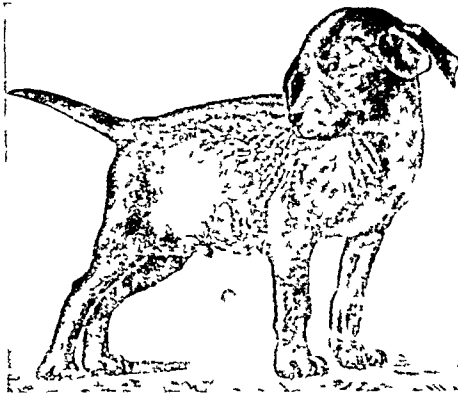


FIG. 3A.

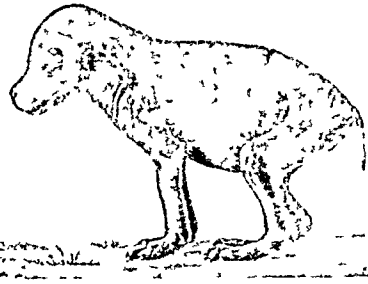


FIG. 3B.

FIG. 3 A, Normal animal B, Dog from same litter with thyroidectomy performed at the age of three weeks (Biedl.)



FIG. 4A.



FIG. 4B.

FIG. 4. A, Normal control rabbit and two cretins (thyroidectomized) from same litter. B, Normal control rabbit (right), and cretin from same litter fed with standard thyroid preparation. (From Basinger.)

physiological salt solution to correct or prevent development of the characteristic intoxication. This treatment is based upon the previously mentioned beneficial influence of similar treatment applied in our experimental work with adrenalectomized animals.

The condition which follows surgical removal of the adrenal glands in animals is not identical with that seen in human beings with Addison's disease. This is to be expected since in one case there is acute total suppression of adrenal function while in the other the disease is more chronic and is usually associated with other conditions, commonly tuberculosis. Nevertheless, certain of the symptoms

The significance of these symptoms has already been alluded to.

In animals deprived of their adrenals under proper surgical conditions there is no significant alteration in the blood pressure during the period of survival until the appearance of symptoms indicating an intoxication. In Addison's disease the blood pressure is low, a condition heretofore attributed to interference with the secretion of epinephrin from the adrenal glands. However, in the light of proof afforded by experiments upon animals and from clinical studies on Addison's disease, we must consider the low blood pressure as a manifestation of the intoxication which results from interference with function of

the interrenal or cortical, rather than of the medullary, tissue of the adrenal glands.

Unfortunately, the diagnosis of Addi-

strate the value of animal experimentation and the importance of continued investigation. The remaining problems will be



FIG. 5. Cretinous child (A) before and (B) after treatment with thyroid. (Byrom Bramwell.) (From Sharpey-Schafer.)

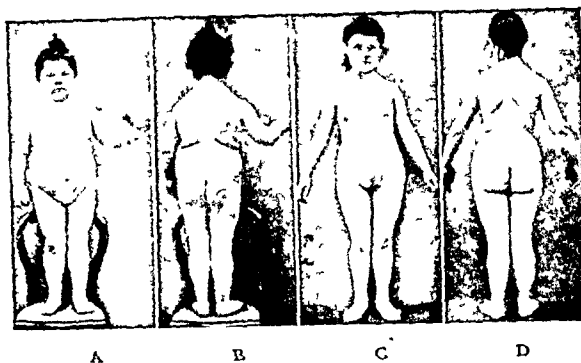


FIG. 6. A and B, Partial myxedema in fifteen-year-old girl. C and D, After treatment for three and one-half years with thyroid medication. (Leopold-Lévi and de Rothschild.) (From Biedl.)

solved only by the aid of further research upon animals.

#### THE THYROID GLAND

A striking example of the indispensability of animal experimentation for the advancement of our knowledge in medicine and surgery is afforded by the progress made during the past twenty-five to fifty years in our understanding and treatment of diseases related to the thyroid gland. Prior to the advent of modern experimental medicine the concepts of thyroid function were based upon anatomy. The intimate relationship of the thyroid with the larynx gave rise to the belief that the gland has the function of lubricating the throat and aiding the voice. This idea existed from the time of Galen up to the middle of the nineteenth century.

A historical review of the subject, which cannot be attempted here, reveals numerous other examples of hypothetical explanations of the rôle of the thyroid based upon anatomy, before the introduction of experimental work upon animals, by Moritz Schiff.

From none of the theories was any progress made toward the recognition and treatment of conditions associated with thyroid disturbances. Nothing was con-

son's disease is rarely made until the intoxication has progressed to the stage where the symptoms are fully developed, including the low blood pressure. But we have observed the existence of the other symptoms (including pigmentation of the skin) when the blood pressure was normal. In such cases the diagnosis has been questioned; but within a relatively short time doubt was removed by a more or less rapid decline of the pressure and perhaps the occurrence of an acute exacerbation with gastrointestinal and nervous symptoms. In these cases, especially, the writer has witnessed remarkable improvement following administration of interrenalin, sometimes supplemented by intravenous administration of salt solution to facilitate elimination of toxic substances. Even marked reduction of pigmentation has occurred.

It is now necessary to isolate the active product "interrenalin" in purer form, and to learn the manner in which it operates, we need also to learn how to recognize abnormal function or deficiency (e.g. Addison's disease) readily, and before irreparable damage is done. The results so far obtained are encouraging. They demon-



tributed to our knowledge of the important metabolic influence of the thyroid and its relation to certain diseases. The successful

## CRETINISM

This condition, also known as "infantile myxoedema" or "cretinoid idiocy" is a chronic disease of childhood characterized by stunted growth, deformity of body, and imbecility. It commonly develops at one to two years of age but may appear soon after birth or at any time up to puberty. Until about a quarter of a century ago it was generally included among the hopeless mental derangements. In certain regions this disease was very common, occurring endemically, especially in goiter districts. Sporadic cases also were not uncommon throughout the civilized world.

Cretinism and myxoedema have been reproduced in animals and the functional derangements as well as treatment have been studied. The function of the thyroid and its relation to myxoedema, cretinism, simple and toxic goiter and certain other conditions, though much better understood are not as yet completely known. The gland possesses a unique affinity for iodine and stores this substance, in organic combination, in a form which is capable of exerting a powerful influence upon metabolism. Baumann, in 1895, demonstrated the presence of iodine in the thyroid and in 1919 Kendall isolated the active iodine compound, *thyroxin*, which is considered to be the specific hormone of the gland.

The relation of iodine to simple goiter has been studied by David Marine and collaborators. He recognized the remarkable affinity of the thyroid for this substance and demonstrated, in animals, that very small quantities of iodides are capable of converting a hyperplastic gland into one possessing the normal colloid material. Their observations led to the use of small doses of iodides as an effective measure for the prevention of simple goiter.

Prior to 1891, treatment of cretinism was utterly hopeless. And then came the use of thyroid extracts and glandular products as remedial agents. The extraordinary results obtained are best de-

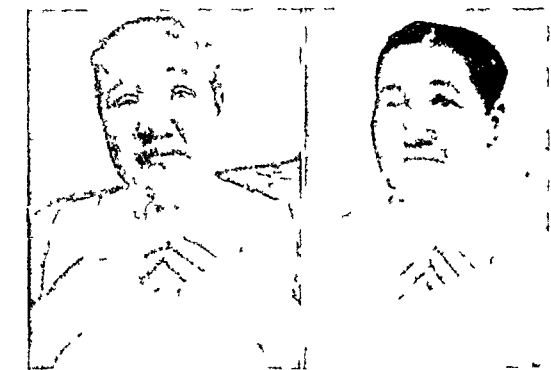


FIG 7A

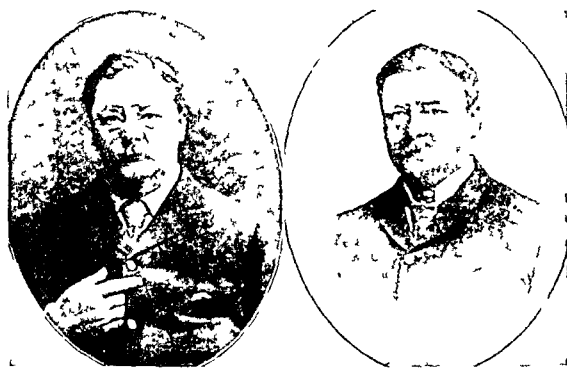


FIG 7B

FIG 7. Upper, myxoedema (A) before and (B) after seven months' treatment with thyroid medication. (Andersson) (From Biedl) Lower, A, myxoedema in man aged forty-four of two years' duration and B, after six weeks' treatment with thyroid extract (Murray). (From Vincent)

treatment of cretinism and of myxoedema, and the prevention of simple or endemic goiter, which have already been accomplished by the aid of animal experimentation, would not have been possible from anatomical studies alone. Functional activity of the thyroid and its relation to functions of other organs are now more clearly understood. More comprehensive information on the physiology of the thyroid and its abnormal function in disease must be obtained by further investigation.

scribed in the words of Sir William Osler (1897), "Not the magic wand of Prospero or the brave kiss of the daughter of Hippocrates ever effected such a change as that which we are now enabled to make in these unfortunate victims, doomed heretofore to live in hopeless imbecility, an unspeakable affliction to their parents and to their relatives."

This is an outcome of experimentation upon animals begun in 1854, by Moritz Schiff. His earlier experiments on removal of the thyroid resulted in death of a number of animals within a few days and survival of others which, however, developed a cachectic condition. About twenty-five years later Schiff was led to repeat his earlier studies, in the light of more recent knowledge. The discovery of the parathyroids, in 1880, by Sandström, Reverdin's successful production of experimental myxoedema, in 1882 and the report by Kocher, in 1883, that 30 per cent of thyroidectomies were followed by a "cachexia strumipriva," led Schiff to repeat his experiments of a quarter of a century earlier and in 1884 he demonstrated that thyroidectomized animals could be saved by previous grafting of the gland. Schiff pointed out the endocrine nature of thyroid function and suggested substitution therapy in myxedema.

The relation of absence of the thyroid to defective cerebral development and myx-

edema was noted by Curling, in 1850. Later, Semon pointed out that cretinism, myxedema and cachexia thyreo-strumipriva are identical. The results of Schiff's experiments led Murray, in 1891, to employ injection of extracts of thyroid in the treatment of these conditions, with satisfactory results. One year later, it was found by Howitz that administration of the gland by mouth is effective. Since then successful substitution therapy, in the treatment of disorders associated with thyroid insufficiency, has constituted one of the most striking achievements of modern experimental medicine.

In the foregoing we have attempted to illustrate some of the chief steps in the evolution of our knowledge in endocrinology. The adrenal has been considered more extensively; since it is one of the most important organs in the body and so little is known concerning its function, it affords an excellent demonstration of the contributions that have been and are being made, in this branch of medicine, chiefly through animal experimentation. Progress is necessarily slow. Every contribution to our knowledge leads to new problems. The process of investigation must be continuous, extensive and cooperative; clinical observation and animal experimentation must be coordinated if the "Art" of healing is finally to find its proper place in civilization as a useful "Science."



## BOOK REVIEWS

**INTRACRANIAL TUMOURS, Notes upon a Series of Two Thousand Verified Cases with Surgical-mortality Percentages Pertaining Thereto.** By Harvey Cushing. Springfield, Ill., Charles C. Thomas, 1932. 150 pp.

The author of this volume is today undoubtedly the outstanding surgeon of the United States, if not of the world. Anything emanating from his pen is entitled to more than usual consideration. Add to this the fact that this monograph consists of a report on over two thousand brain tumors verified by either operation or postmortem examination in one clinic, and it is readily appreciated that we have before us an outstanding work. This volume formed the basis of the report made by Dr. Cushing to the International Neurological Congress held in Berne in September, 1931. His paper was recognized as the principal contribution to this important Congress. While consisting largely of statistics, there have been added explanatory paragraphs whose purpose, according to the author, "was to make the tabulations and percentages appended to the several sections more easily comprehended."

A proper review of this volume would call for a detailed analysis of its contents which is not feasible at the present time. Suffice it to say that anyone attempting brain surgery should have this important monograph at hand for continued reference. It is perfectly astounding to see the amount of information that the author has succeeded in condensing into 150 pages. The 111 illustrations render the production of incalculable value, not only for reference but as an actual handbook for the brain surgeon.

The enthusiasm of the reviewer for this volume could easily lead to his usurping all the space allowed to book reviews in this issue.

**TUMOURS OF THE BREAST. Their Pathology, Symptoms, Diagnosis and Treatment.** By Sir G. Lenthal Cheate, K.C.B., C.V.O., F.R.C.S., and Max Cutler, B.Sc., M.D.,

Phila., J. B. Lippincott Co., 1931. 596 pp., 486 illus.

This volume really includes a pathological atlas and covers this subject as well as any single volume known to the reviewer. The subject is covered completely in fourteen chapters with due consideration to both the surgical and radiological treatment. It contains a complete discussion of pathology and diagnosis.

A splendid volume in every way and one which should find its place in the library of every surgeon who comes in contact with tumors of the breast.

**MONOGRAPHS ON SURGICAL PATHOLOGY.** By Arthur E. Hertzler. Halstead, Kansas. Phila., J. B. Lippincott Co., 1931.

**SURGICAL PATHOLOGY OF THE DISEASES OF BONES.** 272 pp., 211 illus., 1930-31.

**SURGICAL PATHOLOGY OF THE SKIN, FASCIA, MUSCLES, TENDONS, BLOOD AND LYMPH VESSELS,** 301 pp., 260 illus., 1931.

**SURGICAL PATHOLOGY OF THE FEMALE GENERATIVE ORGANS.** 346 pp., 285 illus., 1932.

**SURGICAL PATHOLOGY OF THE GENITOURINARY ORGANS.** 286 pp., 222 illus., 1931.

These volumes are the first of ten which will comprise a complete system of surgical pathology. They present the deep studies of an active surgeon. The idea of a volume on each subject allows of sufficient elaboration to make this a worthy work of reference and a credit to American surgical literature. The illustrations are well selected and carefully reproduced. The bibliography which follows each chapter is complete enough for all practical purposes without being so extensive as to be boresome. The subject is treated so that it may be quickly referred to by the practicing surgeon.

In the Preface to the volume on the Skin, Fascia, Muscles, Tendons, Blood and Lymph Vessels, the author states as follows: "The purpose of the book is to present the result of observations in the clinic, or operating room with only incidental discussions of the findings

of the laboratory. Pathologists will therefore please ignore the presentation of my own views. I have no quarrel either with them or with science; it is the art of medicine I seek to serve." This statement serves as the keynote to the ideas behind this series. Many surgeons will find themselves in complete sympathy with his ideas whereas others will disagree.

If the remaining six volumes live up to the status of the first four, the author will have achieved his aim of "serving the art of medicine."

**CLINICAL ROENTGEN PATHOLOGY OF THORACIC LESIONS.** By William H. Meyer, M.D. Phila., Lea & Febiger, 1932, 261 pp., 183 engravings.

According to the author's preface this is the first of a series of volumes on interpretation of roentgen plates. This volume considers abnormalities and diseases of the respiratory tract and will make a splendid book for the beginner, though of course not nearly as complete as the larger atlases such as the American Sante and the German Assmann. There are 183 illustrations most of them fairly well reproduced. The lack of a bibliography is to be deplored and it is hoped that the author will at least add references for further reading to the various chapters of his future volumes.

**SURGICAL ERRORS AND SAFEGUARDS.** By Max Thorek, M.D. Phila., J. B. Lippincott Co., 1932. 696 pp., 668 illus.

This volume of 700 pages will make valuable auxiliary reading for any surgeon but, particularly, for the young man. Well arranged, well illustrated and well indexed, the volume lends itself particularly well to quick reference in a perplexing case. This is a valuable book for which we predict a large sale.

**THE STORY OF MEDICINE, FROM MEDICINE MAN TO MODERN PHYSICIAN.** By Victor Robinson, M.D. N. Y., Albert & Charles Boni, 1931. 527 pp.

The author of this book has a sense of the dramatic and shows a distinct flair for news and human interest, particularly of the tabloid variety. Here is the story of medicine jazzed

up for this modern age. The cynicism, often miscalled debunking, so evident in historical writing in recent years is here applied to medical lore with a vengeance.

Chapter XII starts off with the following paragraph: "America is the youngest of the great nations, and if it seems strange that we know no more of the first English physicians in America than of the first Greek physicians in Rome, the same reason is operative in both instances. Eminent physicians remain at home, if for no other purpose than to annoy their rivals, and are not likely to be found on the first ship that touches a new shore. In the year that Jamestown was settled (1607), William Harvey was elected a Fellow of the Royal College of Physicians, and his prospects in London looked brighter than in Virginia; when the Half-Moon sailed up the river that we now call the Hudson (1609), Thomas Fryer, Graduate of Cambridge and Padua, was enjoying the honors of Consiliarius, when the Pilgrims landed on Plymouth Rock (1620), the Oxonian Matthew Gwinne was appointed Tobacco Inspector by James I, the royal enemy of the weed. Such men, professionally or socially successful, had no incentive to follow fortune in a wilderness. The social standing that comes to first settlers is always posthumous." Granting all of this possibly to be true, it does not seem that much is added to the undergraduate student's knowledge or respect for history of medicine to have it presented in this fashion.

The story of Burke and Hare, the body snatchers of the early nineteenth century, is interesting. But whether in a book of a little over 500 pages covering the subject from "Medicine Man to Modern Medicine" this dramatic episode is entitled to some ten pages (374-385) is questionable.

The problem presents itself—for whom is this book written? If for the undergraduate student of medicine, it is felt that there are many books ranging from the smaller volumes of Dana, Seelig, Dawson and others through the larger volumes of Baas, Pagel, and the incomparable Garrison, which present the subject in much better fashion for this class of reader. The physician also has numerous volumes at his disposal which will present the information he is looking for far more adequately. For the layman, it will perhaps make more interesting reading than the more serious

volumes. But there is great doubt as to whether it is necessary or desirable to present to the layman all the scandals of medicine which, after all, form the high spots of this volume.

Taken all in all, the book is without a doubt entertainingly written, fairly accurate in its factual presentation but perhaps unnecessarily lurid in style.

**THE FUNDUS OF THE HUMAN EYE, AN ILLUSTRATED ATLAS FOR THE PHYSICIAN.** By Ernest Clarke, C.V.O., M.D., F.R.C.S. Lond., Humphrey Milford, Oxford University Press, 1931. 51 plates.

The author of this modern book on "The Fundus of the Human Eye" thirty-five years ago translated Haab's classic book on this subject. His new work will make a worthy successor of this old standby which has long been out of print. The book should be of especial value to the general practitioner as only the most definite fundus changes have been illustrated. There are fifty-one plates, all of them splendid reproductions. The atlas, which is low in price, should find a place on the reference shelf of every physician using the ophthalmoscope. The specialist, of course, will require more complete works.

**A TEXT-BOOK OF MEDICINE FOR NURSES.** By E. Noble Chamberlain, M.D., M.Sc., M.R.C.P., Foreword by Miss E. M. Musson, C.B.E., R.R.C. Lond., Humphrey Milford, Oxford Univ. Press, 1931, 378 pages.

This book is well named A Text-book of Medicine For Nurses. It is well written, well illustrated, and well planned. The book will undoubtedly meet the needs of the English schools of nursing but in this country will be found by many to contain too many details which are not required in our nurses' training.

It should be in every reference library for nurses.

**GYNÄKOLOGISCHE OPERATIONSLEHRE.** By Prof. Dr. Josef Halban. Berlin, Urban & Schwarzenberg, 1932.

In his introduction, Professor Halban offers as his excuse for the publication of this work on Operative Gynecology, firstly, the existence of a great many methods of performing similar operations; and, secondly, to lend this work his personal equation in relation to, "not only if and when to operate, but also how." In this he has succeeded well; for though the book contains only 435 pages, the author covers indications, methods of choice and technique for all pelvic and most of the abdominal surgical procedures. The reviewer mentions "abdominal surgery" advisedly; for though the book is termed "Operative Gynecology" the author includes indications and operative procedures for all types of hernias, bladder, ureter and kidney surgery; intestinal surgery, and the usual types of rectal operations. Professor Halban feels that a gynecologist should be able to cope with, and be able to perform any operation in the abdomen as well as in the pelvis.

The book is divided into two sections. The first of these is devoted to the discussion of general subjects; as, preoperative preparation, various forms of anaesthesia, including his method of spinal induction, blood transfusion, postoperative treatment of hemorrhage, emboli, etc. In the second part, he covers the indications and the technique of the various gynecological, urological and intestinal operations.

The inclusion in the book of chapters on infertility, artificial insemination, methods of temporary sterilization, etc., makes it all the more interesting.

The four hundred illustrations, many in colors, are superb.



# PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D.

AND

LOYAL DAVIS, M.D.

## FIFTH INSTALLMENT

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## CHAPTER XIX

### SURGICAL TECHNIQUE OF NERVE OPERATIONS

To repair peripheral nerve lesions, it is essential primarily that the surgeon have a practical knowledge of the anatomy of the peripheral nerves and to understand thoroughly the principles of nerve degeneration and regeneration. One must be familiar not only with the general anatomical course of nerve trunks, but also with the origin and distribution of the various branches. In addition, one must have a knowledge of the muscles supplied by the nerve to be repaired. These matters will be considered in later chapters and are concerned now with the technical steps of the surgical procedures commonly employed.

#### PREPARATION OF THE OPERATIVE FIELD

The skin of the extremity to be operated upon should be sterilized carefully well above and below the proposed limits of the incision. This is necessary because the original incision may have to be extended during the operation. Our practice is to wash the entire extremity thoroughly with soap and water before operation. In the immediate preparation of the field of operation we use ether, iodine and alcohol. Of course, the use of antiseptic solutions is a matter of choice for the surgeon. In the repair of nerve injuries during warfare, the use of transplants to repair the large defects in nerve continuity is more common than in civil life. Under such circumstances it is a wise practice to prepare the field from which the transplant is to be taken at the same time.

It is important to arrange the operative sheetings so that the entire extremity is exposed freely. Then it may be observed and manipulated without contamination of the surgical field. As in all operative procedures we feel that the surgeon himself should drape the extremity, since he should have a better



grasp of the problems which may be encountered than have his assistants. That part of the extremity beyond the operative field may be covered with sterile stockinette or in the case of the hand a sterile rubber glove may be put on. It is essential to be able to observe all muscle movements which may be produced by stimulation of the nerve trunk and to be able to move the extremity into any desired position during the operation.

The limb must be placed in a position which will afford the simplest approach to the operative field. These positions vary with the nerve to be operated upon and the site of exposure. Those found to be convenient in our hands have been described under each individual nerve. These postures should be maintained by the judicious use of sandbags or other mechanical apparatus so that an assistant's hands are not so occupied.

### ANESTHESIA

The question of the type of anesthesia to be used in peripheral nerve surgery is an important one. Usually the operations are long and tedious. Above all, the surgeon should not feel under the strain of a necessity to hurry through. However, the choice of an anesthesia cannot lie solely with the surgeon. It is, of course, well recognized that some patients are psychically unsuited for local anesthesia though its administration be perfect. The task of lying quiet upon an operating table, though free from pain, is impossible for some individuals. Consequently, we feel that here as elsewhere in surgery judgment should be used in the choice of an anesthetic. In civil practice we have employed local anesthesia equally as often as we have ether, nitrous oxide-oxygen or ethylene general anesthesia. If a general anesthetic is given, it should be administered by a trained anesthetist who is capable of maintaining an even, light anesthesia.

To produce local anesthesia it is our custom to use  $\frac{1}{2}$  per cent novocaine solution to each ounce of which 10 minims of 1-1000 adrenalin chloride are added. It is essential to produce a line of intradermal wheals along the proposed line of incision.

The subcutaneous tissues may then be infiltrated. It may be somewhat difficult to introduce the solution into the dense scar tissue which may be present. Commonly it is not necessary to inject the nerve trunk directly until the ends are sectioned for approximation. One must remember that while the field may be quite bloodless during the operation, the constrictor effect of the adrenalin may soon disappear and unless careful attention is paid to hemostasis the wound will become quite wet from oozing vessels.

#### EXPOSURE OF THE LESION

The importance of long incisions which will afford an adequate exposure of the nerve lesion cannot be emphasized too strongly. By this it is meant that the incision should extend well above and below the probable site of injury. In other words, the incision must uncover the normal nerve trunk above and below the lesion. It should be a principle never to attempt to find the divided nerve ends in the dense scar tissue which is usually present at the site of the lesion. The contraction of the scar, the bulbous neuroma on the central end of the nerve, the distorted appearance of the peripheral end and the change of the normal anatomical relations will all serve to make identification difficult. The surgeon should expose the normal nerve trunk and then dissect it toward the lesion from above and below. It may then be followed with comparative ease through the scar tissue. If this rule is always followed, the chance of injuring the nerve trunk near the point of injury by mistaking it for scar tissue may be avoided.

During the exposure of the nerve trunk, it must be kept in mind constantly that the further formation of scar tissue must be guarded against. This may be done to a large degree by handling the tissues carefully, insuring complete hemostasis and maintaining a sterile field at all times. A careful clean-cut dissection confined as nearly as possible to normal lines of cleavage should be used. Bleeding vessels should be grasped individually and not in the center of a mass of tissue which

surrounds them. Only the larger vessels which cannot be controlled by crushing should be ligated and then the very finest of plain catgut should be used. Finger dissections should be

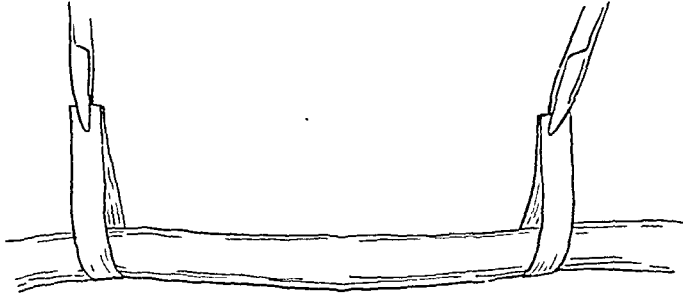


FIG. 110. Use of moist tapes to handle nerve trunk.

scrupulously avoided; in fact, there are no reasons why the fingers of the surgeon or his assistants should enter the wound. Sponging should be done with gauze or cotton pledgelets moistened in normal saline solution. After the nerve has been exposed it should be protected at all times by wet cotton sponges.

If it is necessary to handle the nerve during its exposure it should be done as gently as possible. It has been quite advantageous many times to pass a narrow moistened cotton tape beneath the nerve and to handle it in that manner (Fig. 110). After the ends have been freed from the scar tissue in which they are bound, the nerve may then be handled by its neuromatous ends. It is apparent how essential it is to be familiar with all of the branches of the nerve so as to avoid severing or injuring them during this exposure.

After the nerve and its neuromatous ends have been isolated and freed and before an attempt is made at approximation the surgeon should make certain that the field of operation is bloodless. We have on many occasions used a tourniquet to control bleeding. In our hands the most practical method of constriction has been to use a blood pressure cuff. However, we have had an occasional drop in blood pressure upon release of the constriction and are familiar with other instances in

which the patient went into profound shock immediately after this procedure. In addition, at times we have felt somewhat uneasy at the task of securing hemostasis after the suture line had been completed. Consequently, we have dispensed with the routine use of the tourniquet.

It also may be advisable at this stage to make preparations for the bed in which the sutured nerve is to lie. As has been stated, the most favorable condition is to place the sutured nerve upon the uninjured belly of a muscle or between muscle planes of cleavage. In large destructive wounds with a large amount of scar tissue this is often impossible so that recourse must be had to other methods which will be described later. Yet, at this time, surrounding scar tissue may be handled so that there may be the minimal possibilities of endangering the suture line. The nerve ends should be laid upon wet cotton pledgelets and the surrounding tissues so protected during the approximation.

#### TECHNIQUE OF APPROXIMATION

As soon as the normal nerve trunk has been identified above and below the lesion and before it has been handled in the slightest, a single silk suture should be placed through the epineurium exactly in the midline (Fig. 111). This will prevent accidental torsion of the nerve from its normal axis. As has been stated, it is very important to obtain an approximation of the nerve ends in as nearly the normal funicular apposition as is possible. This is more important in dealing with the peripheral end of the nerve where degeneration will have made it impossible to identify the normal funicular topography either grossly or by electrical stimulation.

The next step is to freshen the nerve ends by sectioning the neuromas until the bulging funicular bundles may be seen. With a sharp safety razor blade the neuroma on the central end should be sectioned successively at intervals of a millimeter until the dense scar tissue has been passed and normal

nerve structure is identified (Fig. 112). The hard, gritty sensation of cutting through the neuroma is quite in contrast to that experienced when normal nerve tissue is encountered.

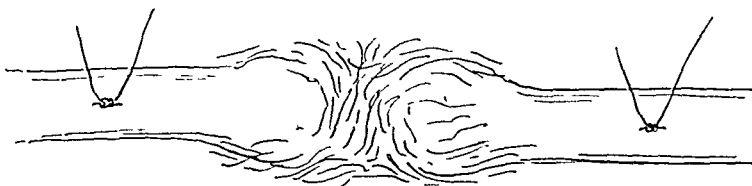


FIG. 111. Use of identification sutures to prevent torsion of nerve.

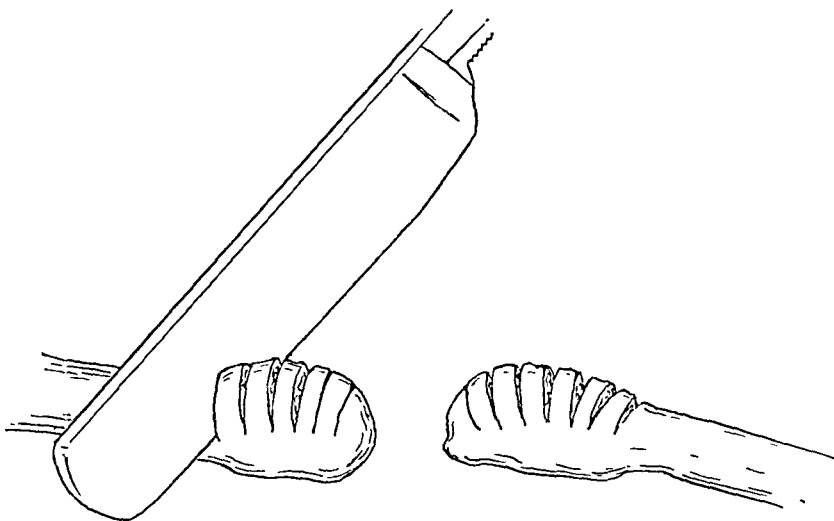


FIG. 112. Section of neuroma with razor blade until normal funiculi are found.



FIG. 113. Gross appearance of normal end of a divided nerve.

This procedure must be continued until the neuroma has been passed completely. The fresh normal nerve end is soft and resembles the end of a cut telephone wire cable with its bundles of nerve fibers bulging out beyond the end of the nerve sheath (Fig. 113). This latter characteristic appearance is not present at the end of the distal segment but one may rely upon the gross

disappearance of the presence of scar tissue. Regardless of how much one increases the gap between the ends of the nerves this step must be carried out thoroughly. The presence of scar tissue in the nerve ends will interfere seriously with the chances of obtaining a successful result. Very often after the neuroma has been sectioned from the central end, there will be bleeding from a small vessel in the epineurium. This may be controlled usually by a warm pledget of cotton but occasionally it is necessary to crush the vessel with a fine mosquito hemostat.

The field is now ready for the actual approximation of the nerve ends. We will describe the methods of apposition in the presence of large gaps later. The sutures placed through the nerve sheath to prevent torsion should be held in the position in which they were placed. The first suture of fine silk is placed through the epineurium only of the central and distal segments. It is important that this suture should not pass between or in any way constrict the nerve funiculi. Similar sutures should be passed in the medial, lateral and posterior quadrants of the nerve (Fig. 114). The posterior quadrant of the nerve trunk may be exposed by pulling the lateral quadrant suture to the medial side. By exerting simultaneous traction upon all four of these sutures the nerve ends are brought into approximation and then each suture is tied firmly but not so tightly that the ends of the nerve fibers are overlapped. The nerve ends should be brought into apposition without exerting tension. Intermediate sutures should then be placed in the nerve sheath around the circumference of the nerve trunk so that none of the nerve fibers gapes through the line of suture (Fig. 115). The sutures should then be cut off just as close to the knot as possible. We use fine silk suture material which is passed through vaselined gauze just before the suture is introduced. The finest Corticelli black silk is separated into its component strands and each of these serves as a suture. Sargent and Greenfield showed that although silk gives rise to a slight tissue reaction, chromic or other chemically treated catgut causes a marked tissue

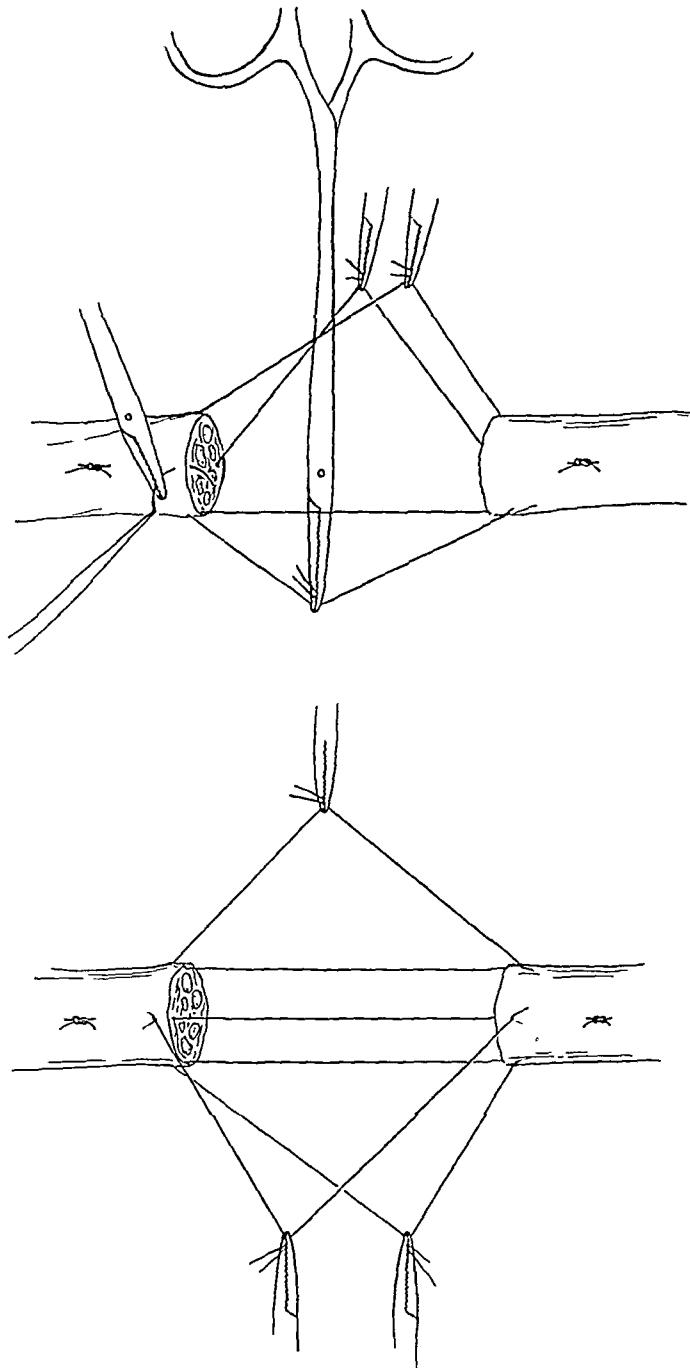


FIG. 114. Sutures placed in quadrants of nerve ends to facilitate accurate approximation.

reaction. It has also been shown that the tensile strength of silk is much greater than that of the finest catgut and yet the reaction of the tissues is less.

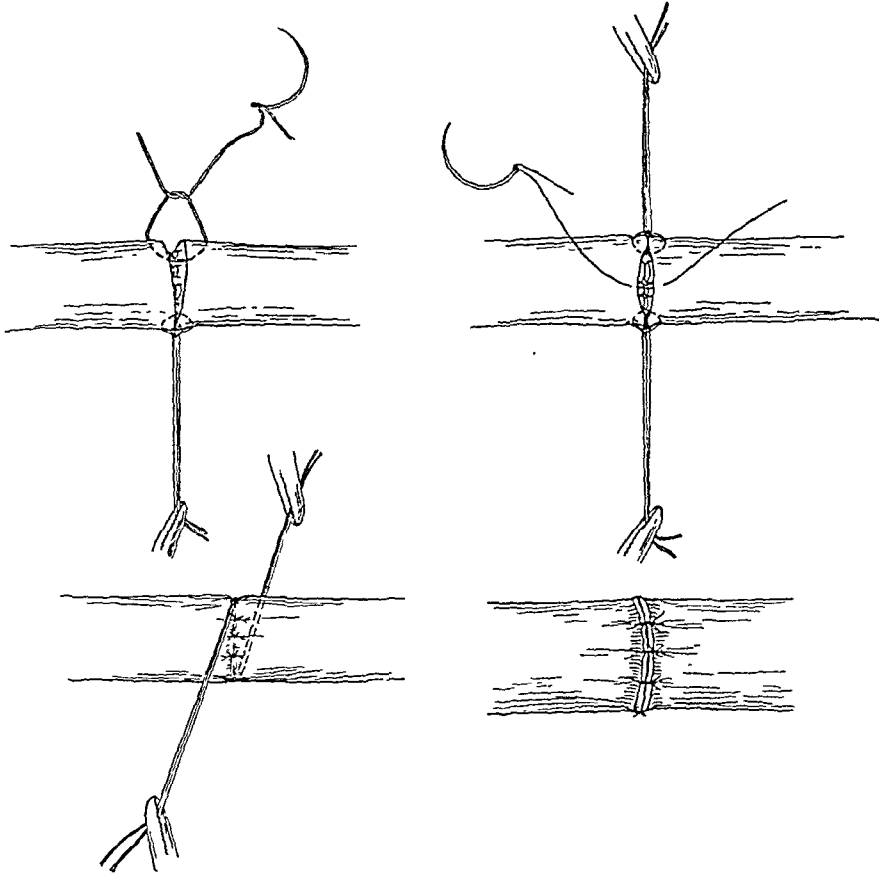


FIG. 115. Technique of obtaining an accurate end-to-end suture.

The united nerve should then be allowed to drop into its bed. As has been indicated, normal untraumatized muscle bellies are preferable as a protection for the sutured nerve. If there is a large amount of scar tissue present in the original bed adjacent normal muscle may be drawn together under the nerve. If this is not possible it may be feasible to place the nerve in a slightly different position without interfering with its function. If neither of these procedures is possible we find that a flap of superficial fat may usually be swung beneath



the suture line. Hemostasis in the field of operation should then be secured completely and the incision closed carefully in layers with fine suture materials.

### METHODS OF OVERCOMING LARGE DEFECTS

Very often a good approximation of the nerve ends without undue tension cannot be obtained easily because of the large gap which exists after the nerve ends have been prepared for suture. It becomes necessary to resort to various methods which will overcome these continuity defects.

**MOBILIZATION:** The majority of the smaller continuity defects may be overcome by careful mobilization of the nerve trunk both below and above the lesion. This may mean only freeing the nerve from its normal bed between muscle bellies. It may be carried out for considerable distances from the lesion. The main point to be kept in mind is that no muscular branches should be destroyed. Occasionally these branches may be carefully dissected free so that their mobilization will add to that obtained in the nerve trunk. Gentle traction upon a mobilized nerve may be necessary and it has been shown that the result of a suture so performed may be entirely successful.

**CHANGES IN JOINT POSITION:** In a large number of cases the nerve ends may be approximated though a large defect be present by utilizing the relaxation of the nerve trunk obtained by changing the position of the governing joints. For example, flexion of the wrist will make it possible to approximate the ends of the median and ulnar nerves in the forearm though a large continuity defect be present. Likewise, the sciatic nerve is more relaxed with the leg in flexion (Fig. 116).

After the suture has been completed the joint must be kept in the position of relaxation. For this purpose we use a dressing of crinoline gauze. This material is starched and stiff but when wet thoroughly it may be used just as a plaster-of-Paris bandage. When the material dries, it again becomes firm and hard (Fig. 117). It will maintain the desired position adequately

and is less cumbersome and much more comfortable than a plaster splint. Later it may be split and removed as a shell so that the skin sutures may be removed. It should be replaced

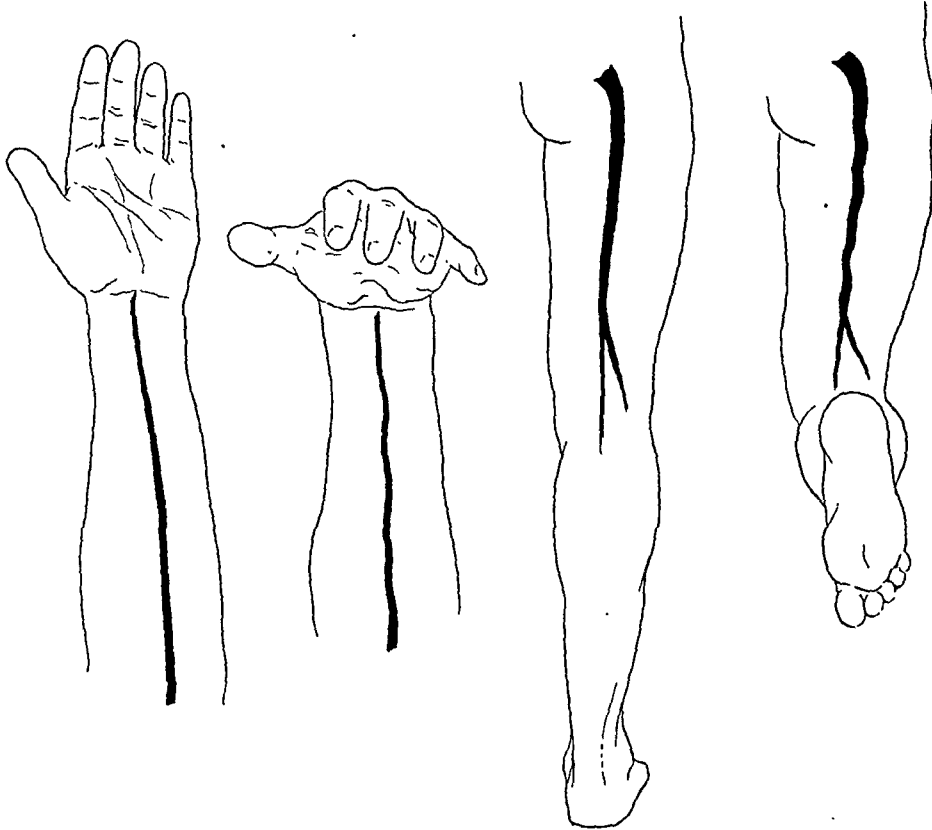


FIG. 116. Relaxation of sciatic and median nerves with leg and wrist in flexion.

so that the extremity is kept in the original position for at least two weeks. After that time we apply a light restraining dressing which will allow the joint to move and yet which will prevent any sudden change of position which might injure the suture line. Miller and Lewis have shown that after two weeks a nerve suture has almost reached its maximal tensile strength. Practically after that period of immobilization, the patient voluntarily graduates the degree of movement more satisfactorily than we can direct.

**NERVE TRANSPOSITION:** In the arm particularly, the anatomical course of the nerves may be shortened considerably by transposition from the dorsal to the ventral surface. This

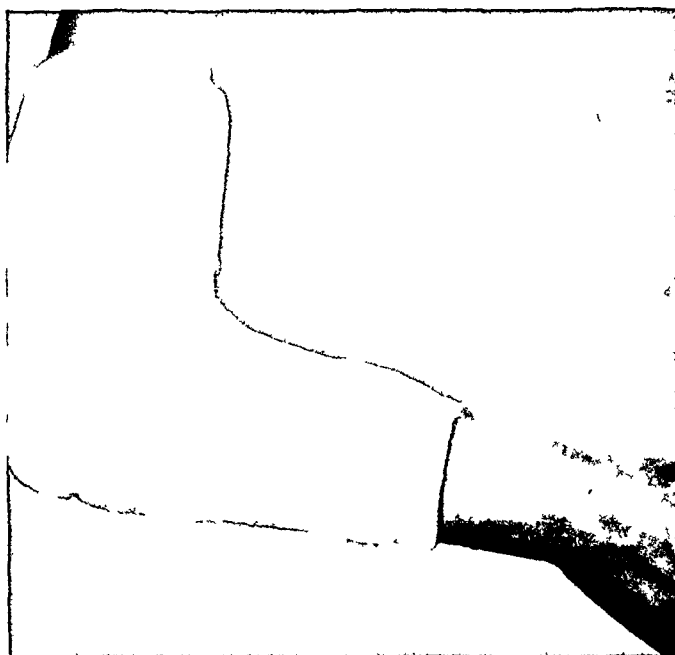


FIG. 117. Use of a crinoline dressing to maintain elbow in flexion after suture of median nerve.

procedure requires a complete familiarity with the various branches given off from the nerve at its various levels so that they may not be sacrificed inadvertently.

No branches are given off by the ulnar nerve in the arm. At a point some 2 or 3 inches above the medial condyle of the humerus, it perforates the internal intermuscular septum to pass behind the condyle in the olecranon groove. Below the condyle it gives off its branches to the flexor carpi ulnaris and the inner heads of the flexor profundus digitorum muscles. It is possible to gain several inches by transposition of the nerve at the elbow from behind the condyle to the flexor surface of the elbow (Fig. 118). It is necessary, of course, to free the nerve well above and below. It is also possible to dissect the branches and

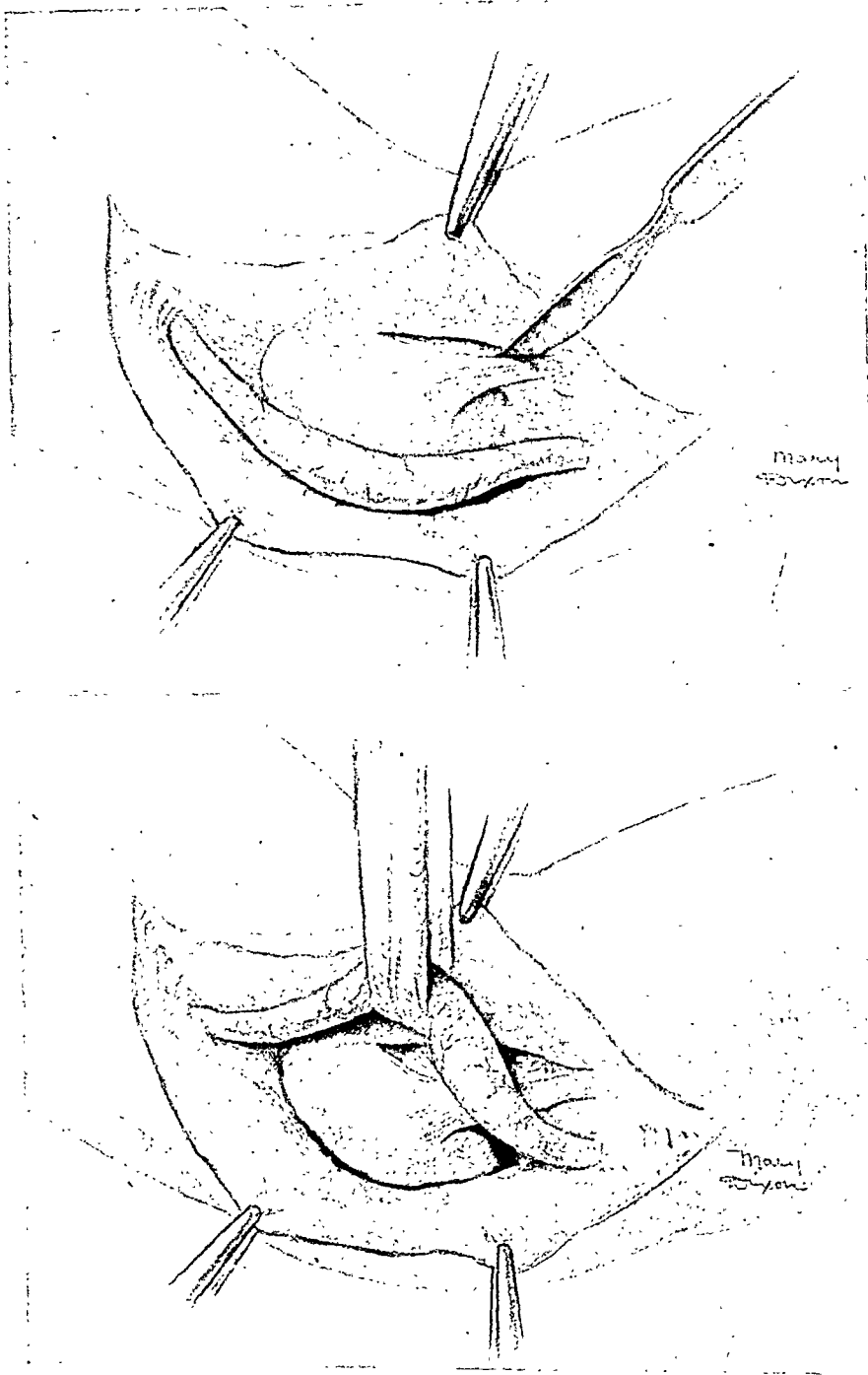


FIG. 118 A & B.

[365]

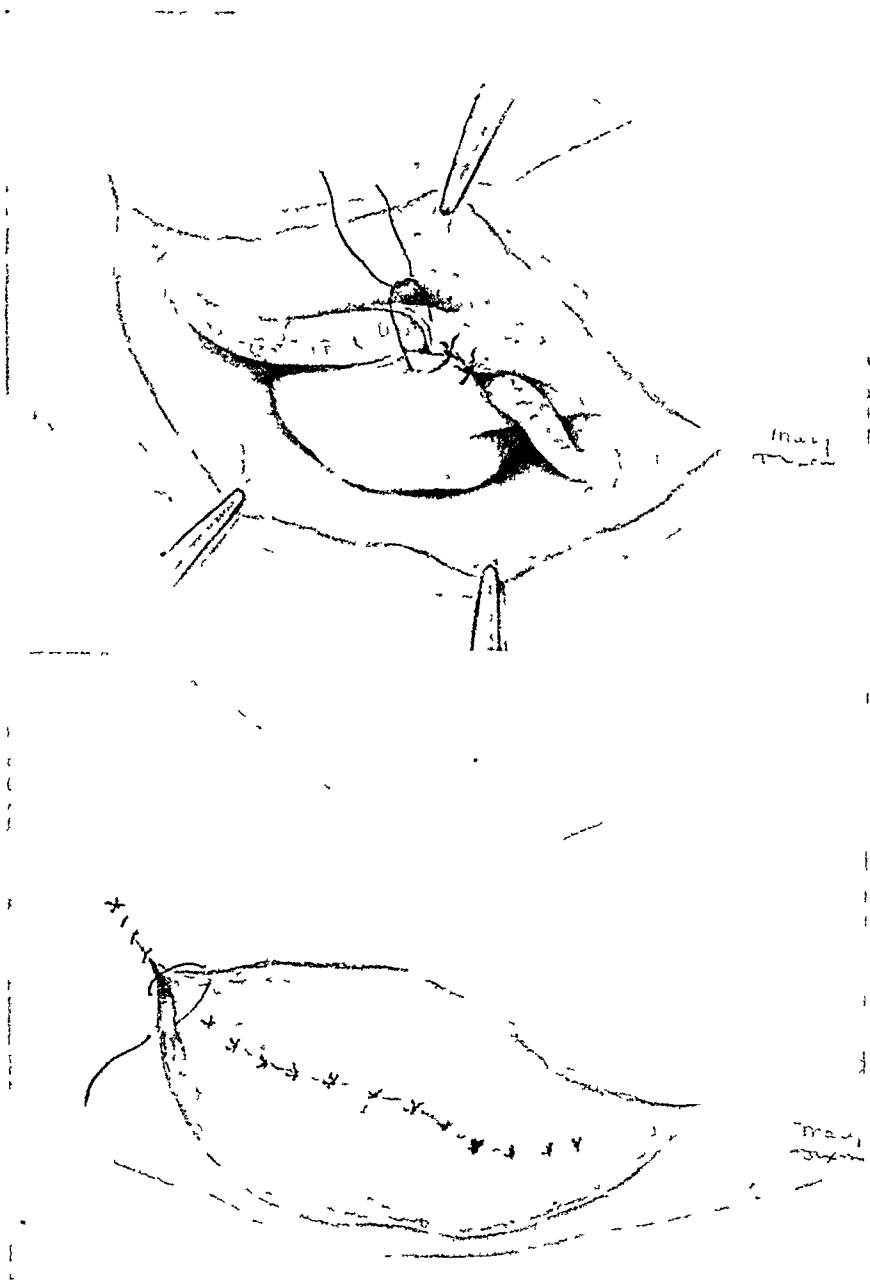


FIG. 118 c & d

FIG. 118. Transposition of ulnar nerve from olecranon groove to flexor surface of elbow.

thus gain more freedom of the nerve trunk. The nerve may then be placed superficially although it may become quite tender because of its superficial position. It is perhaps more satisfactory, though more complicated, to place the nerve beneath the deep fascia and muscles. To accomplish this it is necessary to divide the pronator radii teres and superficial flexor muscles close to their origins from the medial condyle. The ulnar is placed beneath the reflected muscles which are then sutured back into place.

In many instances transposition of the radial nerve to a position anterior to the humerus is necessary because of the extensive scar tissue which involves the triceps muscle and the posterior surface of the humerus. It may also be used as a method to bridge a defect if the lesion is at another level. Two incisions are necessary to accomplish this transposition. The nerve should be exposed by an incision on the lateral side of the lower half of the arm. It should extend downward in the bend of the elbow to the medial side of the lateral condyle of the humerus. The other incisions should be made over the brachial artery in the upper half of the arm. Here the radial nerve is exposed at the lower border of the teres major muscle where it passes posterior to the humerus. The nerve is brought out of its groove on the humerus and is passed posteriorly and to the lateral side of the axillary vessels and the median and ulnar nerves. The biceps muscle is freed so that the nerve may lie in an oblique position beneath it. The nerve then runs directly from the axilla in front of the humerus to the outer side of the ventral aspect of the elbow. Through the lower incision alone it is possible to follow and mobilize the lower half of the radial well up along the groove in the humerus. This procedure permits of a large amount of gain in length.

The median nerve has a more direct course but some lengthening may be obtained by freeing the muscular branches in the forearm and transposing the nerve to a more superficial position.

In the lower extremity the course of the sciatic and its two terminal divisions are such that little gain can be obtained by transposition.

**TWO-STAGE STRETCHING OPERATION:** In some cases the defect to be bridged before end-to-end suture is possible may be so great that none of these methods will suffice. Under such conditions the central and distal ends should be mobilized as much as possible; the neighboring joints should be placed in position to afford the greatest relaxation possible and if necessary transposition should be done. Then the neuromas should be sutured together. After a week's interval the position of the extremity is gradually changed so that the nerve trunk is gradually lengthened by stretching. When the extremity has been fully extended, the second operation is performed. The neuromas are resected and approximation is obtained. It may be necessary again to employ flexion-relaxation of the joints as in a one-stage operation. Experimentally there is no evidence that the regeneration which follows such stretching is any the less successful because of it.

Babcock and Spear state that based upon 160 cases of nerve suture the following continuity defects may be bridged and end-to-end suture obtained by use of one or all of the methods just described:

	Cm.
Cords of the brachial plexus.	7
Ulnar nerve in the arm...	13
Ulnar nerve in the forearm.	13
Ulnar nerve in the forearm without transposition...	5
Median nerve in the arm.....	12
Median nerve in the forearm without transposition	8
Median nerve in the forearm with transposition ..	13
Radial nerve in the arm.....	12
Musculocutaneous nerve in the arm	7
Sciatic nerve ..	12
Peroneal nerve.	10
Tibial nerve..	7

#### TECHNIQUE OF NERVE CROSSING

The technique of approximation in a complete nerve crossing is exactly similar to that described for an end-to-end

suture. The distal end of the nerve trunk to be united is brought parallel to the normal nerve to determine the point at which the latter is to be divided. This point should be chosen carefully so that the suture may be performed without undue tension and so that no angulation results. It may be necessary to resect the neuroma upon the central end of the injured nerve and then to inject it with alcohol to relieve the patient of a painful neuroma. The distal end of the normal nerve used for the crossing will, of course, degenerate.

If a partial nerve crossing operation has been decided upon, the level and size of the segment to be raised should be determined. Two silk sutures are placed in the epineurium and a longitudinal incision the requisite length is made upward in the normal nerve. This incision should be made, if possible, between the funiculi and not through them. This segment is then divided transversely from within outward to avoid further injury to the remainder of the normal nerve trunk. The approximation to the distal end of the injured nerve is then made by silk sutures in the same manner as has been described previously.

#### TECHNIQUE OF NERVE GRAFT

The same careful attention to technique as has been described in an end-to-end suture must be observed in performing a nerve graft. The principles of such an operation have been described. The success of a graft operation depends upon the accuracy with which the ends of the grafts are approximated to the central and distal ends of the nerve. Incorrectly placed sutures, or those tied too tightly, may bring the lateral surfaces of the grafts in apposition to the ends. A sufficient number of grafts must be used to cover the entire cross-section area of the central and distal stumps. It is obvious that it is difficult to judge the success or failure of such a method when so much depends upon the individual technique of each surgeon.



Stookey has devised and described a technique which is simple and efficient. The injured nerve is freed from scar tissue, mobilized as much as is possible and its central and distal ends

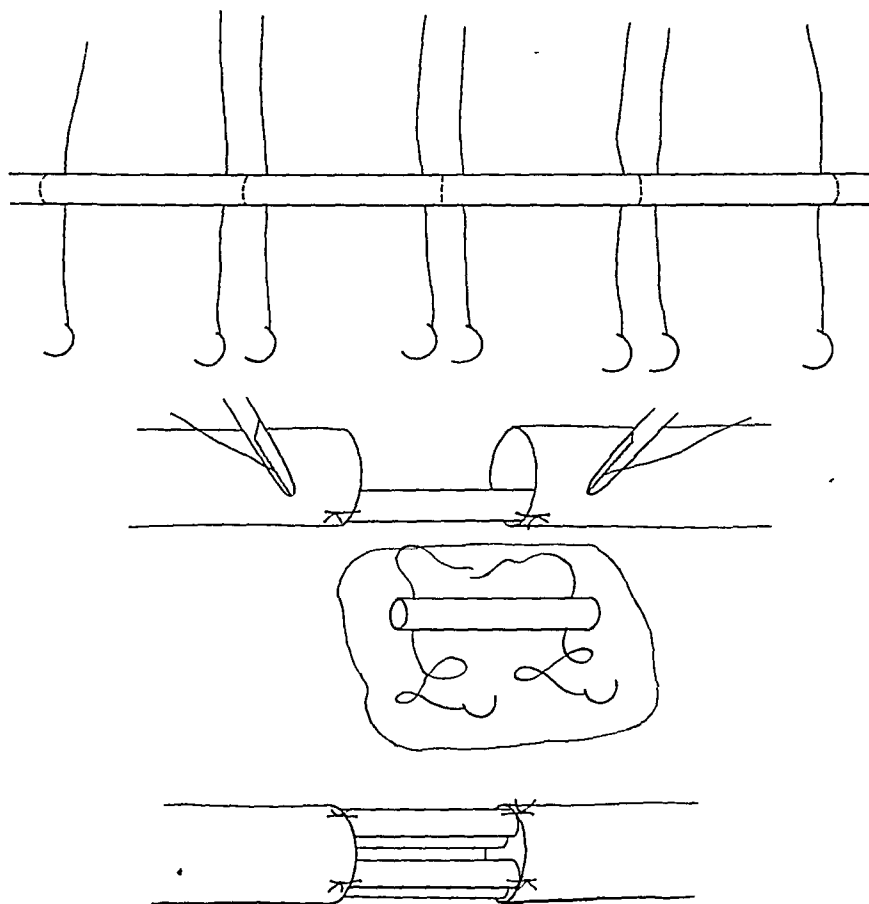


FIG. 119. Technique of nerve graft operation. (After Stookey.)

are prepared as in end-to-end suture. Alignment sutures to prevent torsion are placed in the upper and lower segments. The distance to be bridged is measured accurately. The nerve to be used for the grafts is then exposed and at intervals which correspond to the length of the grafts to be used, two silk sutures are placed. A small but sufficient interval is left between the sutures so that the segments may be divided. The sutures

are all placed in one direction so that the needles lie upon one side and the free ends on the other. Each segment is then placed upon a moist warm cotton pledgelet. This prevents

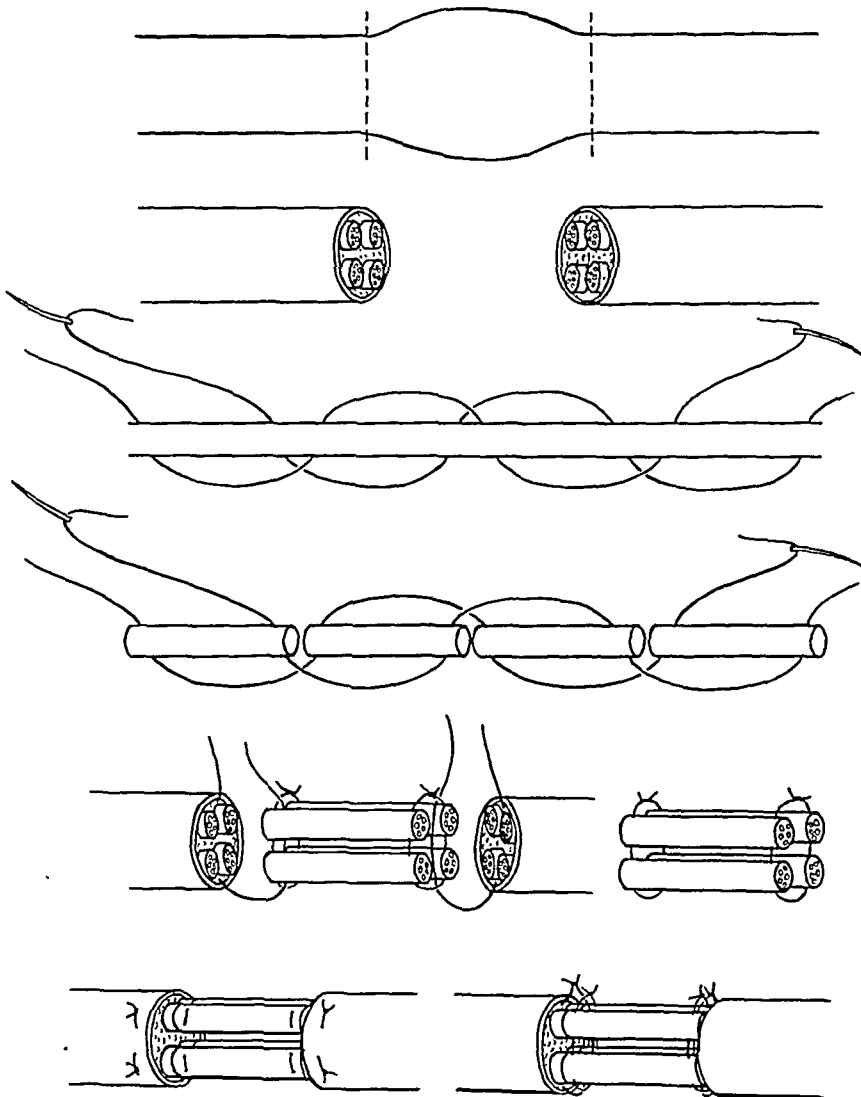


FIG. 120. Elsberg's method of nerve grafting.

handling the segments directly or with tissue forceps. Each segment may thus be placed into position on the cotton pad and sutured separately to the nerve, in whatever position is desired. (Fig. 119.)

Elsberg has described a technique of suturing which permits the approximation of the entire cable graft as a whole. His description of this method is as follows:

Let us say that the graft is to be 7 cms. long and is to consist of three strands. The one suture (A) is passed through near the attached upper end of the freed nerve, from the inner to the outer side of the nerve; a loop is left loose and the needle is then passed through the nerve from the outer to the inner side a little more than 7 cms. from the first point; again a loop is left, and the needle is passed through the nerve, from its inner to its outer side, at the same distance from the last point. The needle is then laid aside and a second needle and suture taken. This needle (B) is passed through the lower end of the nerve, from its outer to its inner side, a little more than 7 cms. from the point of emergence of needle A. A loop of the suture is left and the needle passed through the nerve, from the inner to the outer side, at a point 3 mms. above the point of emergence of suture A; finally, the needle is passed through the nerve, from its outer to its inner side, 3 mms. proximal to the next point above. The points at which the suture A has passed through the nerve correspond to the upper ends of the graft; and the points through which needle and suture B have been passed correspond to what are to be the lower ends of the strands. After the loops have been carefully arranged, the nerve is cut with fine scissors or a fine scalpel: (1) 1 mm. above the beginning of A, (2) 1 mm. below the beginning of B and (3) between each two points through which sutures A and B are passed apart in the nerve. An assistant then grasps the two ends of suture A and the operator the two ends of suture B. When traction is made, the strands are drawn together. Then each suture is loosely tied. A brings all of the upper ends of the strands together; B brings all the lower ends together. After the cable graft has thus been made, it is transferred to its place between the divided ends of the main nerve and sutured in position. [Fig. 120.]

#### TECHNIQUE OF REPAIR IN PARTIAL NERVE LESIONS

Occasionally a nerve may be only partially injured as the result of a bullet or stab wound; from a surgical injury in debriding a wound, or removing a nerve tumor; or by a spicule of bone in a fracture. It is extremely important in the treatment of such lesions not to injure the nerve further in attempts at repair. If the nerve exhibits a central or lateral neuroma partial excision and approximation are indicated. The sheath

of the nerve trunk should be opened over a considerable length and the normal funiculi should be separated carefully from those involved in scar tissue. Those bundles which pass directly into the scar tissue should be isolated above and below the scar and stimulated with a weak faradic current. If this stimulus evokes a response it may be assumed that the bundle in question is anatomically intact and it should be freed carefully from the scar tissue. If, on the other hand, no response occurs, the infiltrated area must be resected and the ends approximated by a suture passed directly through the bundle. It may be necessary to remove a v-shaped portion of the sheath of the nerve to facilitate approximation of the bundle of fibers. The nerve sheath is either left open or only partially closed and the defect covered by an untraumatized muscle sheath or by a pedicled fat transplant. If a nerve trunk is not completely divided and retains only a small amount of functional integrity it is wiser to perform a complete section and an end-to-end suture.

#### TECHNIQUE OF NEUROLYSIS

Attention has been called to the difficulty of making a diagnosis between complete physiological and complete anatomical lesions of nerve trunks. If a physiological lesion has been diagnosed and sufficient time has elapsed without evidences of spontaneous regeneration, surgical exploration is indicated.

External neurolysis consists in the complete exposure and removal of all scar tissue which may compress or strangulate the nerve trunk. After the nerve has been freed, if it is found to be soft and without any evidence of intraneural fibrosis, this procedure may be quite sufficient.

On the other hand, if the nerve is indurated and hard an internal neurolysis is indicated. The nerve sheath should be opened widely and held open by traction sutures. If the compression is due to a thickened and infiltrated nerve sheath and the bundles are quite normal in appearance this simple decom-

pression effect of opening the nerve sheath is all that is required. However, the funiculi may be matted together (Fig. 121). They must then be dissected free by separating them gently from

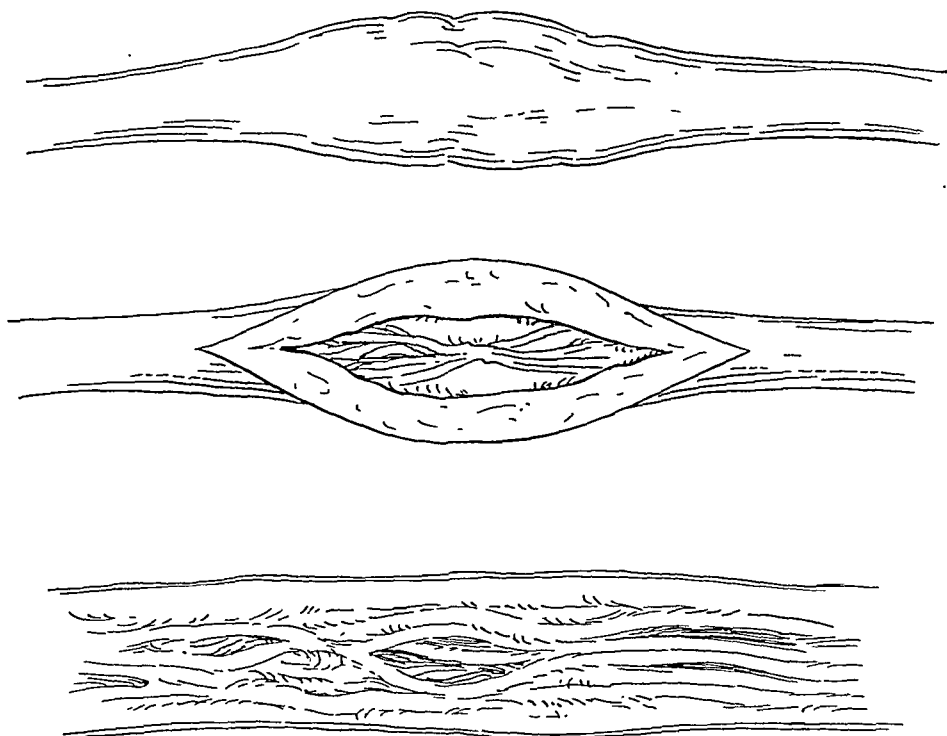


FIG. 121. Method of performing a neurolysis.

these fine intraneural adhesions. The density of this intraneural scar may be determined by the injection of warm normal saline solution into the nerve at the site of the lesion. In a normal nerve this procedure is followed by a fusiform swelling and separation of the funiculi. If the scar is dense the solution will not enter. The injection of the fluid not only determines the density of the scar but also breaks up fine adhesions which may exist. If this method is not sufficient the blades of a fine scissors may be introduced and spread gently between the funiculi. The presence of intraneural plexuses in normal nerve trunks must not be mistaken for adhesions. It is probable that if the

injection of salt solution is not sufficient to accomplish an internal neurolysis, any method of dissection regardless of the nicety of technique will be followed by more harm than good.

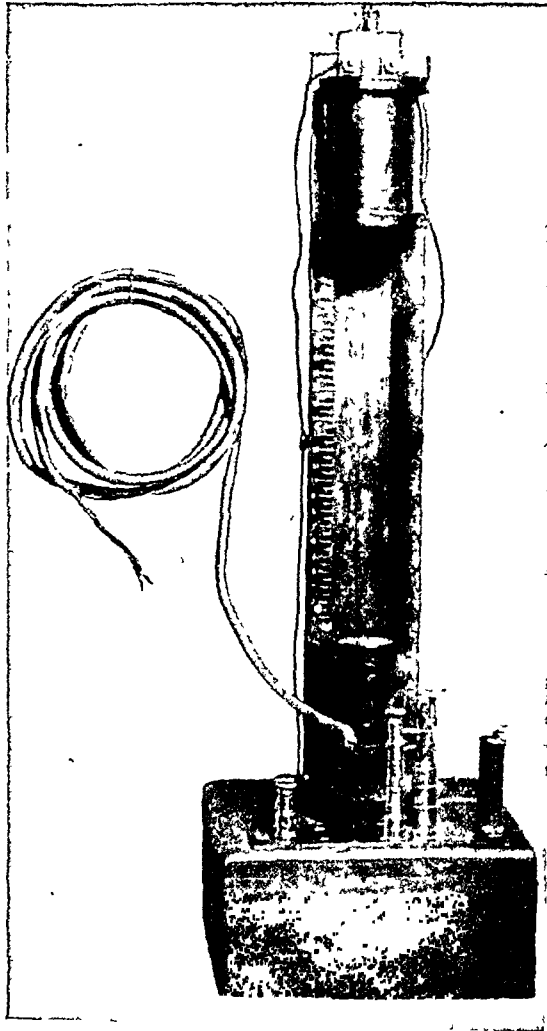


FIG. 122. Apparatus for stimulating nerves at operation. Electrode can be sterilized in an autoclave.

Under such conditions excision and end-to-end suture should be performed.

## ELECTRICAL EXAMINATION OF NERVES AT OPERATION

An apparatus to stimulate the nerve trunk when it is exposed during the operation should always be at hand. All that is necessary is a dry cell, an inductorium, a make-and-break key and a stimulating electrode. The latter should be a fine-pointed bipolar electrode of copper or silver wires which may be sterilized. The ends of the electrode should be separated about 2mm. The weakest current possible should be used to begin the stimulation and this may be increased gradually by approximation of the secondary to the primary coil. Electrical stimulation is invaluable to determine the functional integrity of a nerve trunk or its component bundles. Too much emphasis cannot be placed upon the lack of surgical judgment used when the function of a nerve trunk is tested by pinching with a forceps or hemostat. It may be safely assumed that the response of muscles to a weak faradic stimulation of the nerve trunk above the lesion speaks against the seriousness of the suspected lesion (Fig. 122).

## CHAPTER XX

### POSTOPERATIVE TREATMENT

The after-treatment of patients who have had a peripheral nerve injury is equally as important as the operative procedure. It is not sufficient to expose a severed nerve and to suture it, unless one can enable the patient to return to a satisfactory social and economic position in life. This is not a fanciful ideal for which to strive. It may be accomplished in many instances, in spite of the neglect which many of these patients receive either because of their own carelessness or their doctor's lack of interest. It is of little value to have sutured a severed nerve and have regeneration of its fibers occur, if the effector mechanisms are shortened, contracted, fibrosed and ankylosed. To strive for a result which is the normal physiological function of the part involved should be the aim of treatment in these cases. This can be attained in the majority of cases by the help of *passive* and *active exercises*, *massage*, *electrotherapy* and *splints*, if these agencies are employed correctly and at the proper time.

#### PHYSICAL THERAPY

As Langley has pointed out, intermittent passive or active stretching forces lymph, and so presumably metabolic products, from the muscles. This, of course, should be an advantage. Moreover, such active or passive movements have a distinct influence upon the formation of connective tissue. It is said that there is a visible increase of connective tissue in microscopic preparations of a muscle three weeks after section of its nerve. Part of the late contractures may be due to the shrinkage of this newly formed tissue which is soft and extensible. Active or passive movements of the denervated muscles will stretch the developing fibers so that when they do shrink there may be less tendency to a contracture. The cut ends



of a nerve may become rather fixed to the surrounding connective tissue so that movements may cause a greater pull upon the nerve. However, Langley has shown that in this pre-suture period the tension so placed upon a nerve is not sufficient to cause a rupture of the degenerating fibers.

In many operations it is necessary to fix the limb in a flexed position to permit the cut ends of the nerve to be brought into end-to-end apposition. In such instances passive movements designed to bring the limb into its normal position may be begun about two weeks after the suture has been made. Miller and Lewis have shown experimentally that the tensile strength of a suture line is as great at the end of that time as it is weeks later. This is an important fact which allows passive and active movements to be instituted before formidable ankyloses and contractures have occurred.

Passive exercises may be carried out very well in conjunction with massage. They help to stretch contractures which have already occurred and to prevent those which invariably occur in a denervated muscle. They also increase the range of motion in an already stiffened joint and help to keep a mobile joint active so that when the time comes it is ready to perform its part in an effector mechanism. Finally, such movements help to re-educate the muscles in performing normal movements. These exercises should be carried out slowly, gently and never with quick, jerky movements. Each separate passive exercise should be individualized and the patient should be required to make the attempt to perform the movement simultaneously or to attempt to hold the part in the position imposed upon it.

In many instances active exercises may be employed to great advantage. For example, a median or ulnar nerve lesion at the wrist does not affect the innervation of the long flexor muscles of the fingers and the wrist. Unfortunately, it is common to find the phalangeal and carpal joints ankylosed or the muscles atrophied simply from disuse. As Kanavel has pointed out, in practically every case of joint or muscle injury, passive

motion of the injured part with the help of the sound member, combined with voluntary exercises will accomplish a great deal toward the restoration of function if the patient has

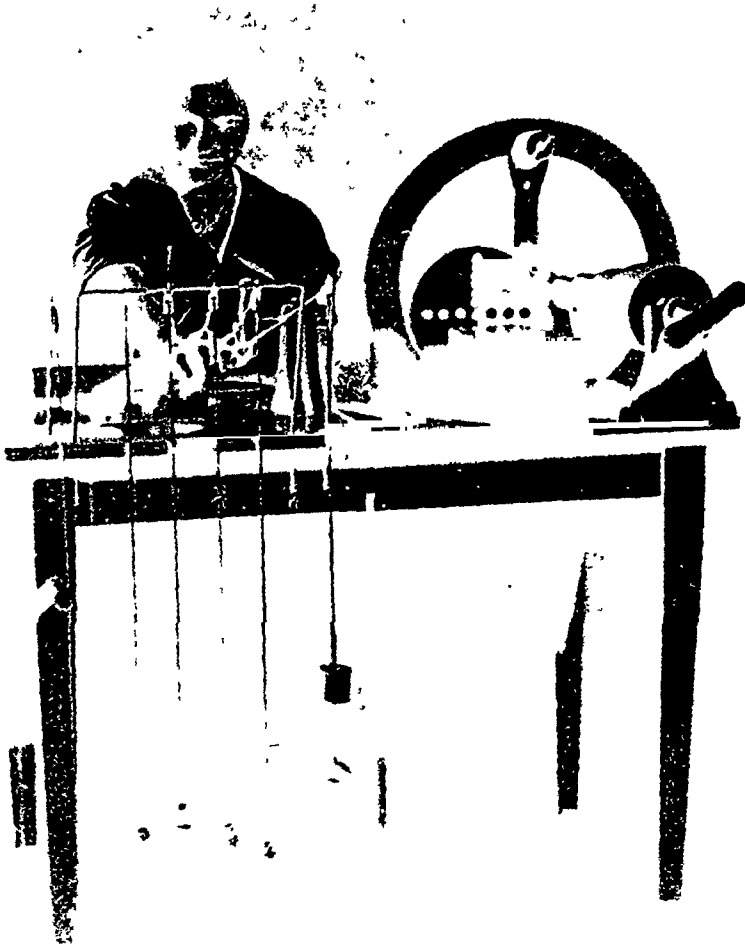


FIG. 123. Apparatus for exercising and stretching flexor tendons of fingers, for obtaining abduction and adduction of fingers and for developing other functions of hand and wrist.

sufficient intelligence and energy. Figure 123 illustrates a device for exercising and stretching the flexor tendons of the fingers, for obtaining abduction and adduction of the fingers and for developing other functions of the hand and wrist. The

wrist and forearm are strapped into position and the fingers are inserted into glove tips. Weights are added until the patient can just lift them, and as function improves heavier weights may be added. Games are of great value in effecting unconscious and effortless exercise of contracted muscles or ankylosed joints. Grasping a soft rubber ball to throw it, playing the piano or practicing on a typewriter are of particular value. For exercising the joints of the hand and wrist, hand ball, dumb bells and Indian clubs are also helpful. It must be recognized that most individuals require a definite goal to accomplish in each type of active or passive exercise instituted to maintain their enthusiasm during the long period of treatment which is necessary.

Before *massage* is begun the part should be exposed to heat for twenty to thirty minutes to obtain as much relaxation as is possible. Radiant heat, the infra-red light, hot packs or a whirlpool bath of warm water are all useful but should be used with extreme care, particularly because of the ease with which it is possible to burn the skin of a denervated area. The whirlpool bath is preferable because the motion of the water acts as a gentle massage which is pleasing to the patient and gives relief from pain.

Before beginning massage the extremity must be placed in a comfortable position with all of the muscles completely relaxed. The position of the extremity which is maintained by a splint should be held throughout the treatment. There never should be stretching upon the denervated muscles. Massage is begun with a period of rhythmic superficial stroking to obtain further relaxation. This may be given in either direction, whichever is more pleasing to the patient, and the pressure must be so gentle that even centrifugal stroking will not interfere with the circulation. Following this gentle stroking, all of the muscles of the extremity should be massaged with a centripetal motion to effect the venous and lymphatic circulation. More pressure should be used than previously but care should be taken not to injure the paralyzed muscles by compressing them.

against the bones. This may be increased gradually until the massage consists of a gentle kneading.

With the extremity placed in the position of function the patient is directed to perform each normal movement of the paralyzed muscles. As the patient makes this attempt the extremity is passively carried through the complete normal range of the motion. As each normal movement is attempted the patient may be instructed to perform the same movement simultaneously in the normal limb. As the function returns the patient performs such part of the movement as is possible. The entire movement is completed as before by correlating the assistance in such a manner that there is no pause in the complete movement. The number of times each motion is repeated increases from two or three times at the beginning to eight or ten as function returns. Care should be taken never to cause fatigue. Gentle kneading and stroking should follow these movements.

If superficial scar tissue is present friction massage should be used. This is obtained by pressing deeply and moving the hand in a circular direction. The outer tissues should be moved over the underlying structures with a minimum of movement on the surface. If the scar is dry, a lubricant may be used at the end of the friction massage but its use in the beginning makes deep friction impossible. If adhesions and contractures are present, they must be stretched slowly and gradually. Stretching must not be carried to the point of causing pain or tenderness following the treatment and the return to the original position must be done as slowly and as carefully as the stretching movement. Gentle kneading of the contracted muscles and friction over the ankylosed joints may be performed during this procedure.

### ELECTROTHERAPY

The indications for electrotherapy are to prevent atrophy of muscles and fibrosis, to increase nutrition, to conserve

the functional capacity of paralyzed muscles until sufficient nerve regeneration has taken place to permit of active motion.

The efficacy of this type of treatment has been called into

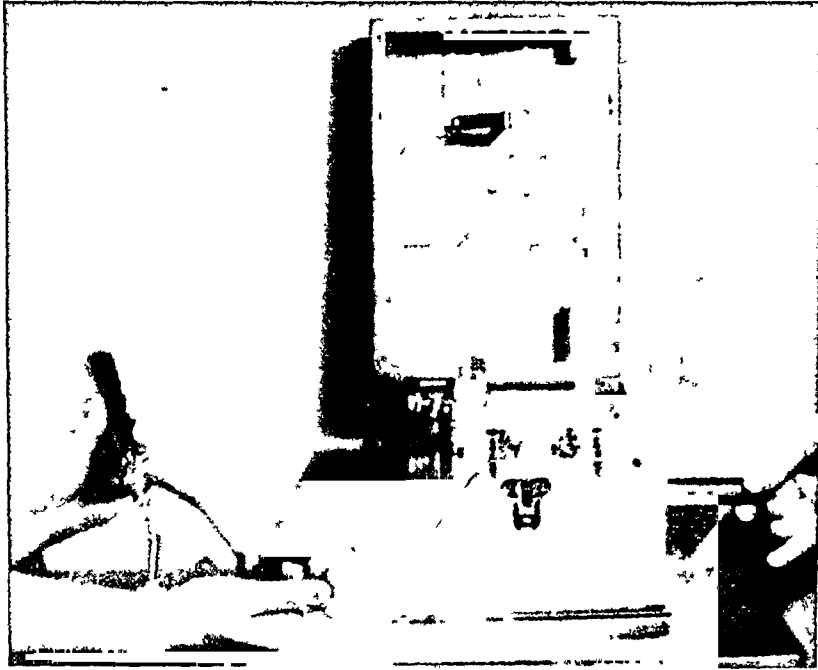


FIG 124 Bristow coil for obtaining muscular contractions with faradic current.

question on a number of occasions. Although since the days of Duchenne neurologists have universally agreed that electrotherapy is of service in hastening the return of function of muscles paralyzed as the result of lesions of the lower motor neuron, some physiologists have decried its usefulness (Langley). On the other hand, many physiologists upon the basis of experimental studies have determined that there is a sound foundation for the belief that electrotherapy is serviceable in the treatment of peripheral nerve lesions. Not only have most of the workers found decreased atrophy in treated cases, but recently Piontkowsky has shown that a more advanced type of regeneration of the nerve occurs when the denervated extremity is treated by electrotherapy (Fig. 124).

It is necessary to understand clearly the mode of action of treatment by electricity. It is not concerned with any mysterious force acting directly upon the factors influencing recovery

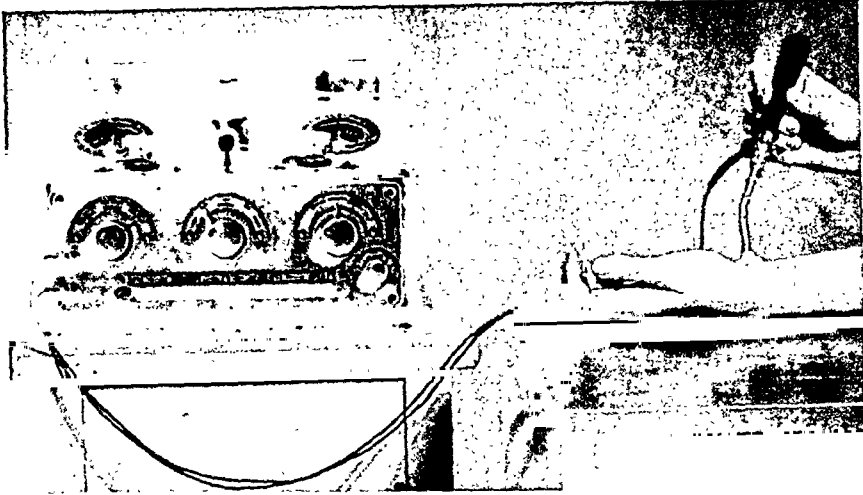


FIG. 125. Apparatus for obtaining muscular contractions with sinusoidal current.

of a nerve or muscle. Stimulation by an electric current of sufficient strength produces a contraction of the muscle. It is this active contraction of the muscle which conserves its bulk and nutrition and keeps the muscle fibers functionally adequate for voluntary movement when regeneration has progressed sufficiently. In cases such as facial nerve paralysis, contractures are diminished and associated movements so often of disfiguring and annoying consequence likewise are prevented. The only requirement of electrotherapy is that it produce a contraction of the paralyzed muscle. Obviously, this cannot be brought about by stimulation with the faradic current, as the duration of each shock is too short in relation to the changed chronaxia of the nerve and muscle. Galvanic current must, therefore, be used. It may be used in its simple form of a continuous current, or in the form of sinusoidal currents of various types of waves (Fig. 125).

It has been proposed that continuous current which at the make or break produces a sharp, shock-like contraction, is of

little value as it does not resemble a normal contraction of the muscle, which it is said is imitated by the contraction ensuing as the result of stimulation by the sinusoidal current. Of course, the criticism that it acts only locally may be met by the statement that larger electrodes should be used. That muscles contract slowly in their normal state has never been shown to be the case by physiologists. The twitch contraction due to electrical stimulation is thought to be analogous to the phasic contraction of all skeletal muscles. It may, we believe, be accepted as a fact that the contraction of a muscle resulting from stimulation by galvanic continuous current is as useful as that produced by any other type of galvanic current. The rapidity of the contractions can produce no harm after the second week following injury or surgical procedures, and during the first two weeks the muscles should be kept practically at rest, as they are fragile and are easily bruised. After this period sudden contractions are just as useful as slow ones. The force of the contraction can, of course, be modified by the strength of the current. Galvanic continuous stimulation is often painful; therefore, other types of waves are useful as they are relatively painless and can be used to advantage in children and sensitive patients. It is necessary to remember that the contraction of a muscle occurs only upon making and breaking the current. Therefore, it is needless to treat the muscle by prolonged stimulation and the current should be applied with very short makes and immediate breaks of the current by using a suitable electrode. The stimulation may be obtained by using bipolar or unipolar methods. In the former both poles are applied to the muscle which it is desired to stimulate. In the latter an indifferent electrode of a large size is placed elsewhere upon the body, as described under electrodiagnosis. During the first few months following injury, while the muscles are hyperirritable, and an increase of direct myotatic irritability may be demonstrated by percussion, unipolar stimulation will produce contraction in the muscles most effected by the weakest currents, because of longitudinal stimulation. Care must

be exercised, therefore, not to produce too great fatigue in these muscles. One must always keep in mind the fact that in many cases deep muscle sense is defective and the patient is unable to tell when the muscles are fatigued. After the first few months, the muscles most affected become less irritable and unipolar stimulation produces a spread of current to unparalyzed muscles, which alone may contract, to the injury of the patient. At this time bipolar stimulation is of greater value. A clear knowledge of anatomy and function of muscles is necessary to produce the most benefit. Particularly is this true of the small hand muscles. Inasmuch as the nerve itself is not irritable to stimulation, the electrodes need not be placed upon the motor points of the muscles, as is the case in paralysis of the upper motor neuron. However, even the muscle may contract more readily at these points.

Although polar inversion is not always the rule in degenerated muscles, it is sufficiently the case so that the positive pole should be used as the active electrode. This is also the least painful.

In producing contractions of the paralyzed muscles, care must be exercised to prevent the force of gravity acting against the contracting muscles, not only to prevent one from detecting movement of segments around the joints, but to prevent fatigue. Upon stimulating the extensors of the wrist no movement may be seen if the wrist is held dependent, whereas if it is supported upon a board at its ulnar border extension may take place. The extensors of the foot may not produce a movement with the extremity in a position of foot drop, but if the patient rests the leg on a board at the outer surface, dorsal flexion may occur. The patient's extremities must be fully supported and the segments about joints so supported that movement is not impeded by gravity.

Contractions of muscles produced by electric stimulation are a valuable adjunct to reeducation and active motion. Although the patient may not be able to produce extension at the wrist voluntarily, the hand may be held in this position



after electrically produced extension has occurred. A voluntary contraction of a muscle may be possible after it has been produced by electrical stimulation, and the patient should be required to attempt such a movement during the period of treatment. Of course, one should always keep in mind the law of regeneration. When it is remembered that the extent of regeneration of the nerve after section and suture is 1 mm. a day, it is futile to have the patient attempt active movement before the fourth month in such cases. In severe compressions recovering without operation but associated with complete degeneration of the distal segment, the same conditions hold true. Care must be exercised in treating areas of skin in which sensation has been destroyed, as burns are readily formed and when ulceration once occurs healing is difficult.

When the nerve and muscle have recovered sufficiently to contract to faradic stimulation both galvanic and faradic stimulation are advisable; the latter to produce more prolonged or tetanic contractions. An apparatus which permits of stimulation by gradual increase and diminution of current, such as is possible with a Bristow coil, is valuable as it is less painful. Here again it is necessary to state that during the period of severe degeneration the faradic current will not produce a contraction of the muscle, and no contraction means no treatment.

Sinusoidal current and other forms of wave currents have only the advantage of relative painlessness. There is a seeming advantage in the fact that at times a larger electrode is used and rhythmic contractions produced in large muscle groups. This is a disadvantage and care should be exercised to stimulate only the paretic muscles.

### SPLINTS

Just as the purpose of massage, exercises and electrotherapy is to maintain the nutrition of the denervated muscles, so the first aim of mechanical splints should be to prevent overstretching of the paralyzed muscles, to restrict shortening of

the normal antagonistic muscles and to maintain as nearly as possible the normal range of the joints and tendons of the affected extremity.

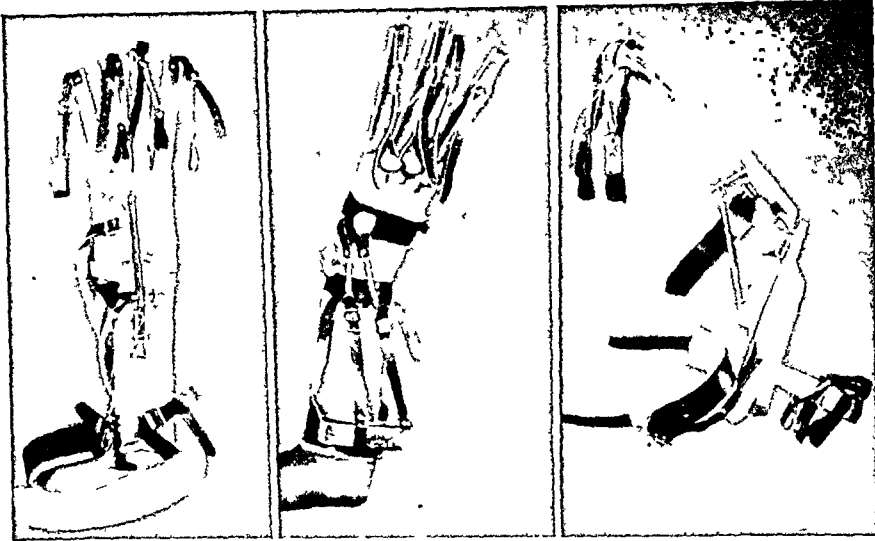


FIG. 126. Aluminum splint by which elastic traction may be obtained to overcome contractions of tendons and ankylosis of joints in neglected cases.

One cannot dogmatically recommend a single splint for each type of peripheral nerve injury. Each case is an individual problem and the splint should be devised to fit the patient and his injury. In general, the splints may be divided into the fixed or immobile and the mobile types. Both kinds of apparatus attempt to correct postural deformities and prevent overstretching of the muscles. In addition, the mobile splints aim to replace part of the movement lost. Necessarily they are more complicated and involved. The fixed splints are more simple and if their use is accompanied by intelligent physical therapy we believe they are more practical.

The ideal type of a splint should be light, simple, easily applied and removed, inexpensive and as inconspicuous as possible. We have found that splints made of aluminum are very practical. It is quite simple to change the character of these splints from time to time as recovery of function occurs.

It is, of course, quite wrong in many cases to use the original splint when the purposes for which it is required have changed with the improvement in muscle and joint function (Fig. 126).

The character of the splint required also depends greatly upon the time which has elapsed between the original injury and the institution of treatment. Because of loss of tissue it may be necessary to fix a joint in flexion or extension to obtain a direct end-to-end suture of the severed nerve. It is wise to remove a constant fixation splint as early as possible and replace it by a splint which may be removed temporarily to allow passive movements and other forms of physical therapy. We have found that a cast of starched crinoline is as efficient as a plaster cast and is much lighter and more comfortable for the patient during the period of constant immobilization.

If such a forced position is unnecessary, then the problem presented by the patient who appears for treatment shortly after the nerve injury may be met by a light efficient splint which relaxes the denervated muscles and prevents overstretching. At the same time shortening of the antagonistic muscles is prevented.

A more difficult and complicated problem is offered by the patient who comes for treatment long after the original injury and with fibrosed joints and stretched, atrophied muscles. A splint should be so devised as to maintain the part in as nearly as possible its normal position of function. Traction upon ankylosed extended phalangeal joints should be elastic and easily varied as conditions change. More specific statements about the types of splints we have found to be most useful may be made if we briefly consider each individual nerve injury and the deformity which accompanies it.

**ULNAR NERVE LESIONS:** Paralysis of the ulnar nerve is easily recognized by the appearance of the hand, with clawing of the little and ring fingers, inability to grasp objects between the thumb and forefinger because of paralysis of the adductor pollicis, and inability to make a cone of the hand by approxi-

mating the tips of the fingers and thumb because of paralysis of the interossei. Lateral movement of the fingers is possible only through supplementary movement, and the patient is unable to innervate the muscles of the hypothenar eminence.

Although many devices have been constructed for the treatment of ulnar nerve lesions, in general, the majority of cases recover more completely without the use of these cumbersome appliances. They interfere with the motility of unparalyzed muscles which suffice to move all of the segments about the joints of the hand. The only disabling complication which follows ulnar nerve lesions is clawing of the little or little and ring fingers. Passive movement commonly suffices to prevent this. When it appears that clawing will result as a consequence of overaction of the extensor communis digitorum, a simple posterior splint for the little and ring fingers may be applied. Extension of the distal phalanges of the little and ring fingers may be defective because of overextension of the proximal phalanges, and a device which prevents these phalanges from overextending is useful in recovering lesions. A narrow strip of metal running diagonally across the palm from the base of the third to the base of the little finger, then bent to continue in the opposite direction over the dorsum of the proximal phalanges of the little, ring and middle fingers is often serviceable.

**MEDIAN NERVE LESIONS:** Paralysis due to a lesion of the median nerve produces an inability to oppose the thumb to the little finger, to abduct the thumb at *right angles* to the palm, to flex the index finger as in making a fist or clasping the hands, and to flex the distal phalanx of the thumb.

For the most part, what is true of the ulnar is likewise true of the median nerve. There is but little clawing of the index or middle finger and flexor contracture of the index finger does not occur. The only troublesome complication is a shortening of the adductor of the thumb, and at times it is necessary to hold the thumb in abduction at right angles to the palm. A light, hollow aluminum ball between the index finger and thumb with the fingers semiflexed assists. A hollow cylinder will serve the same

purpose. Occasionally an apparatus which by means of a spring supplants the abduction of the thumb may be serviceable, although in general springs are unsatisfactory.

*Combined ulnar and median nerve lesions*, when complete, produce inability to perform any flexor movements of the fingers or hand. Under such a condition a simple anterior splint supporting the hand in a slightly flexed position suffices. Clawing occurs in all of the fingers and counter-pressure should be exerted against the dorsum of the proximal phalanges. The thumb should be fixed in a position of abduction at right angles to the plane of the palm.

Partial lesions of these two nerves are particularly liable to be complicated by adhesions, shortening and deformity, and require much more attention than complete lesions.

**RADIAL NERVE LESIONS:** A lesion of the radial nerve at the most common site of injury in the middle of the arm is followed by paralysis of the long supinator, the extensors of the wrist, fingers and thumb. The triceps is partially affected but sufficient function always remains so that it is unnecessary to consider it in devising a splint.

Consequently, the main deformity is a wrist drop. It is necessary only to attempt to perform movement of the fingers and the thumb with the wrist in full flexion to realize how disabling this deformity may be. Without correction the extensors very quickly become overstretched so that even with a return of innervation they may be unable to act. A splint must therefore be one which prevents or corrects a wrist drop. Many complicated and rather cumbersome appliances have been described for these patients. However, a simple light apparatus which dorsiflexes the wrist to an angle of about 50 degrees, which also extends the metacarpophalangeal joints and abducts the thumb, is all that is necessary. A splint constructed of light spring steel wire which extends to the elbow and is applied to the volar surface of the forearm is quite efficient. Such a splint has been described by Buercki and was used extensively in the United States Army. It may be wise

to have a spring joint at the wrist instead of a fixed support so that voluntary flexion of the wrist may be possible. This is not only convenient but there are certain advantages to be

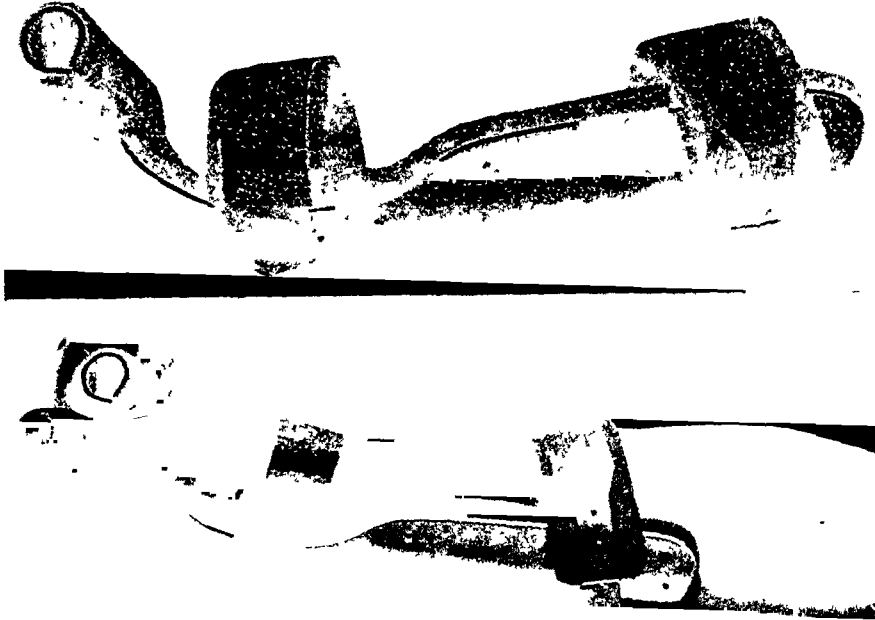


FIG. 127. Simple splint for overcoming wrist drop of radial nerve paralysis.

obtained for the passive recoil of the wrist to the extended position (Fig. 127).

MUSCULOCUTANEOUS NERVE LESIONS: Stookey has described a simple and efficient apparatus which may be used to aid in the treatment of lesions of this nerve. The important muscle which is paralyzed is the biceps. Fortunately, there is little or no likelihood of overstretching the biceps or of marked shortening of the triceps because of the mechanics of the elbow joint and the fact that other unaffected muscles act upon both the shoulder and elbow joints. However, at night a mechanical support which keeps the forearm flexed and the hand in full supination should be worn. Stookey's apparatus consists of a broad leather cuff attached to the wrist and dorsum of the

hand. The wristband has a metal plate which is shaped to fit the dorsum of the hand and wrist. Supination is maintained by a strap fastened to the wristband over the volar

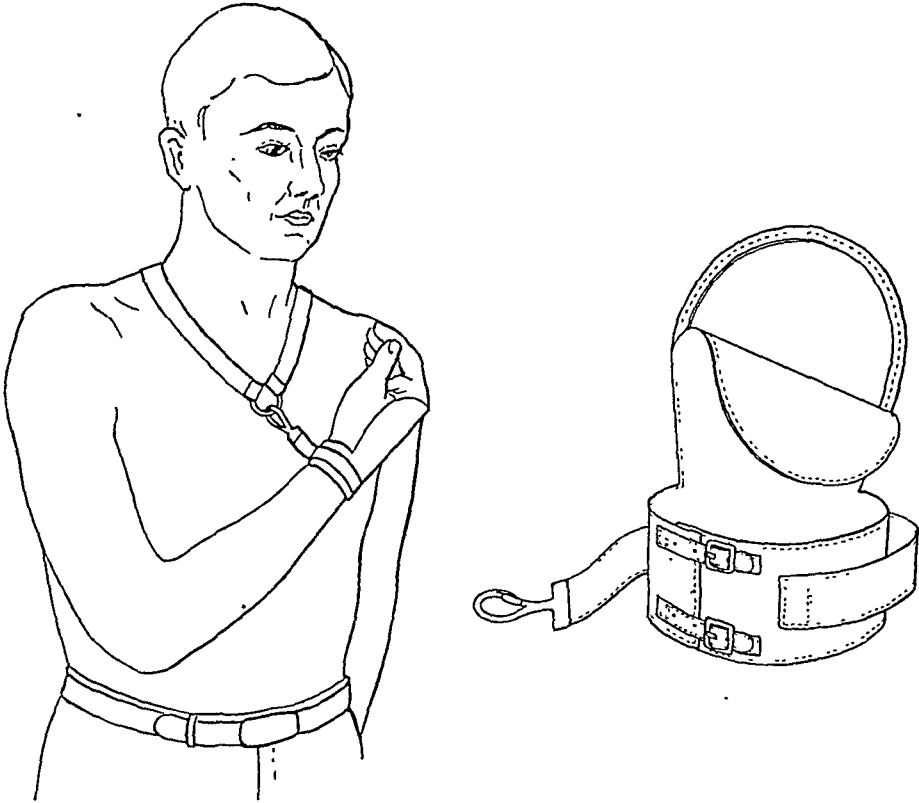


FIG. 128. Splint for use in musculocutaneous nerve lesions. (After Stookey.)

surface of the radius, which passes outward and under the wrist. This strap is then fastened to a collar piece by a pin or snap (Fig. 128).

**BRACHIAL PLEXUS LESIONS:** Of all of the peripheral nerve lesions none requires more constant and efficient mechanical treatment than those of the brachial plexus. This is true because the deformity is so extensive.

As has been pointed out previously, in general lesions above the clavicle are injuries of the roots and primary cords, whereas

those below the clavicle or in the axilla include the secondary cords and nerve trunks. These latter are frequently accompanied by injuries of the axillary blood vessels. There are two

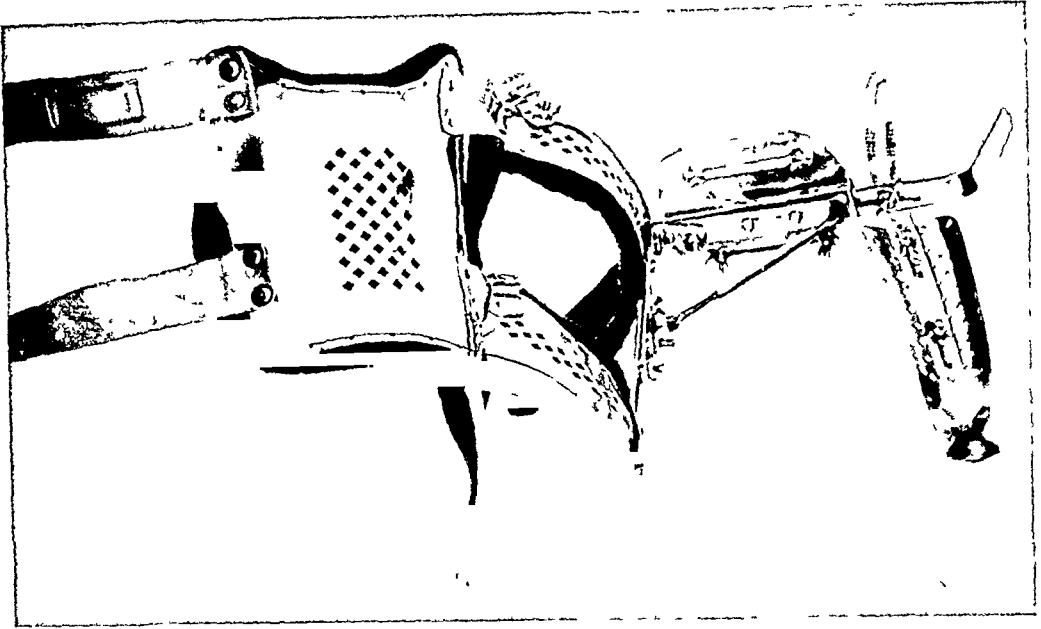


FIG. 129. Splint for use in brachial plexus paralysis to provide abduction of arm.

general types of supraclavicular injuries; the Erb-Duchenne or upper root group which involves the fifth and sixth cervical roots and the lower root group, or the Klumpke-Dejerine type, which involves the seventh, eighth cervical and first thoracic roots. In the former, the resulting paralysis is extensive and involves the muscles of the shoulder girdle and back as well as muscles of the arm and forearm. In the Klumpke-Dejerine type the paralysis is essentially of the ulnar side of the forearm and all of the muscles of the hand (Fig. 129).

In those lesions in which the muscles of the back (serratus magnus, rhomboids, levator anguli scapulae) are involved the deformity is extensive. The compensatory movements of the scapula are diminished or absent. The action of the serratus magnus in fixing the scapula so that the deltoid may act is gone and this must be kept in mind in devising mechanical support. The arm lies adducted with inward rotation. The



humerus may soon subluxate and in old neglected cases may be dislocated completely. The coracoid process becomes prominent and the forearm is held in semipronation. Because the entire extremity is rotated inward the palm of the hand may face backward. Left alone without mechanical support these lesions are followed by permanent and irreparable deformity.

A splint must be designed to relax the deltoid and the supraspinatus muscles and at the same time hold the arm in external rotation. The arm must be held in abduction, preferably at an angle of about 60 degrees, rather than in abduction at 90 degrees. The arm should be rotated externally and the forearm flexed upon the arm and held in moderate supination. Stookey has described a satisfactory splint for these cases. It is made of aluminum and consists of a chest, adjustable arm and forearm piece. The arm piece is hinged and may be adjusted to various angles of flexion.

The deformity present in the Klumpke-Dejerine, or lower root, type of paralysis is similar to that seen in combined median and ulnar nerve lesions. A slight straight splint on the volar surface of the forearm with grooves for each of the fingers proves quite satisfactory. The straps should be placed so that voluntary extension of the fingers is possible.

**SCIATIC NERVE LESIONS:** Paralysis of all of the muscles supplied by the sciatic nerve is uncommon even with a complete section of the nerve high in its course. The branches to the semitendinosus and long head of the biceps are given off at the level of the ischial tuberosities and consequently these muscles are spared. The semitendinosus alone is able to perform the functions of the hamstring muscles to a high degree. It is also able to supplement the action of the gastrocnemius in flexing the leg upon the thigh. (Fig. 130.) However, all of the muscles below the knee are paralyzed and the leg is flaccid, while the foot is dropped and in a valgus position. It is necessary to stabilize the leg and foot, to correct the equinovalgus deformity and to overcome faulty deviation of the body weight.

The most effective and comfortable splint is one based upon the Thomas caliper type (Fig. 131). It is light, comfort-

able and efficient. It should be so arranged with a spring lock at the knee joint that, while sitting, the knee may be flexed to an angle of 45 degrees. A sole plate should extend from the

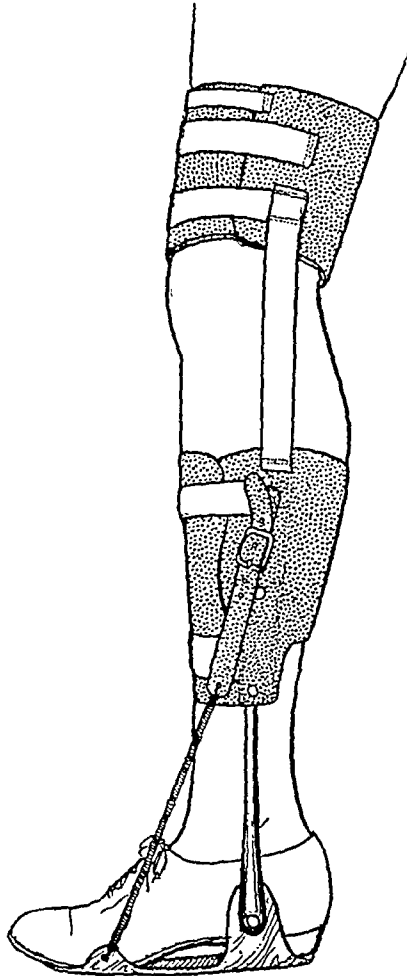


FIG. 130. Splint for use in sciatic nerve paralysis.

heel to the metatarso-phalangeal joint and should be attached to the upright so that the foot is held in dorsiflexion. The heel of the shoe should be raised on the inner side and the shoe reinforced there so that the valgus deformity will be corrected and at the same time the patient will bear his weight upon the outer side of the foot when he walks. This will aid the weakened arches which naturally accompany these lesions.

**PERONEAL NERVE LESIONS:** The deformity in these cases is one of foot drop and a varus deformity due to complete paralysis of the anterior and lateral muscles of the leg. The

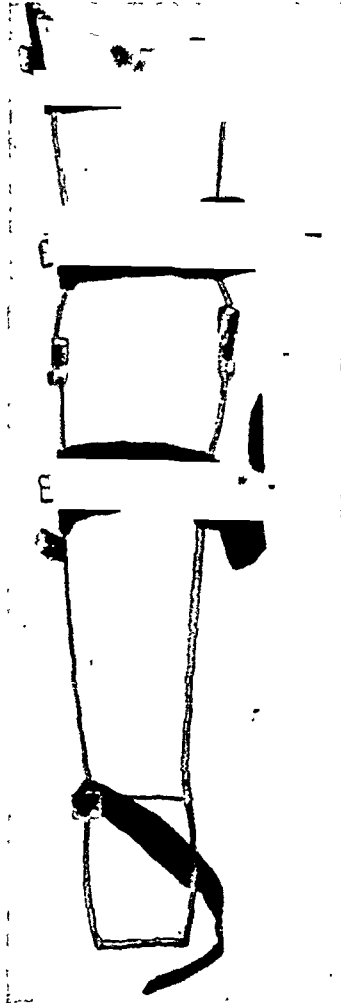


FIG. 131. Thomas caliper type of splint for paralysis of lower extremity.

os calcis is raised considerably because of the unopposed action of the gastrocnemius. Flat foot occurs because of lack of support to the arches by paralysis of the peroneal group and extensors attached to the inner side of the foot. The gait is a very serious disability because of the overaction necessary to keep the toe from scraping the ground.

It is necessary to splint these patients for more than a toe

drop. A light iron strip on the inner side of the leg attached to the shoe with a stop lock will prevent a foot drop. It should be so attached that it raises the foot in dorsiflexion. The iron strip is attached above to a leather band about the leg. The leg should be elevated on the outer side from the heel to the toe to deviate the body weight to the inner side of the foot. This will correct the varus deformity. The ankle joint may be supported if necessary by a leather reinforcement sewed to the shoe. The flat foot may be corrected by an inside plate which should be made to fit individually by molding plaster casts of the foot deformity. The principal aim must be to correct all of the deformities and to prevent those which may result from the improper distribution of weight bearing. The patient should be cautioned never to walk without proper support of his foot. A rubber band or metal spring may be attached to the shoe and the upright to aid in replacing the lost action of the extensors (Fig. 132).

**TIBIAL NERVE LESIONS:** The deformities present in these cases are practically the opposite of those described as the result of injuries of the peroneal. The unopposed action of the peroneal muscles pulls the foot into dorsiflexion and the os calcis is directed downward instead of backward. The foot tends to assume the valgus position and the longitudinal arch flattens because of the paralysis of the *tibialis posterior* and the small muscles of the sole of the foot.

Mechanical support may be given in the form of a light iron strip on the outer side of the leg attached to the sole of the shoe. This should have a stop lock which will prevent dorsiflexion to more than a right angle. The inner border of the sole and heel should be raised so as to deviate the body weight to the outer side and to correct the valgus position. As in the case of the peroneal deformities, an inside plate fitted individually should be worn to support the weakened arches.

The splints for these two latter types of deformities cannot be worn at night but their main action should be replaced by canvas appliances which will effectively prevent overstretching of the paralyzed muscles. Without the use of these nocturnal

supports all that has been accomplished during the day may be easily undone.

**FEMORAL NERVE LESIONS:** As has been stated, lesions of



FIG. 132. Two types of splints for correction of foot drop of peroneal nerve paralysis.

this nerve are accompanied commonly by injuries to the pelvic vessels and viscera. Consequently, one is not called upon frequently to provide mechanical support following such a lesion. However, the quadriceps femoris, sartorius and pectineus muscles are paralyzed and there is an inability to extend the leg upon the thigh. These patients are unable to stand upon their leg unless the knee is in extreme extension. The knee joint soon becomes so unstable that it may suddenly flex and allow the patient to fall. When walking, these patients usually bend forward and place their hand on the thigh to keep the knee joint securely extended. The tensor fascia lata may act to hold the joint in fixed extension and then the patient assumes a swinging gait. In old neglected cases a genu recurvatum may develop.

Mechanical treatment must provide stability to the knee joint and yet prevent hyperextension. A Thomas caliper splint with a spring lock which allows of flexion of the knee only while sitting is the most efficient type of splint. A broad band in the popliteal space will prevent hyperextension and the occurrence of genu recurvatum.

**FACIAL NERVE LESIONS:** The facial muscles must be protected from overstretching and sagging after interruption of their nerve supply just as are other muscles. The mechanical



FIG. 133. Simple elastic splint for the muscles of face in facial nerve paralysis.

support of these muscles contributes tremendously to the recovery of their action after a nerve supply has been reestablished. In neglected cases the muscles may become so stretched that an eversion of the lower eyelid may occur.

The simplest type of support consists of two adhesive straps. The point of pull should be attached to the temporal area. The supporting straps should be attached to the skin about the upper and lower lips. The ends of the two straps may be attached by a rubber band so that an elastic pull upward is maintained. This support must be worn constantly. It is simple and is easily detached during massage, electrotherapy and active exercises which are practiced by the patient. (Fig. 133.)

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## NEWER SURGICAL METHODS OF TREATING DISEASES OF THE VASCULAR SYSTEM\*

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PHILADELPHIA

THE flow of the blood through the normal channels of the body is associated with factors so variable as to render the hydrokinetic interpretation of the circulation difficult or impossible. Alterations in the rate, force and capacity of the heart; constant changes in the contractile and elastic walled blood vessels; variable influences from without the blood vessels from muscles, respiratory movement, gravity, atmospheric pressure and position in space introduce such a multitude of constantly changing factors as to baffle the investigator who attempts accurately to evaluate the forces involved in the circulation of the blood. Fortunately, there are certain basic hydraulic laws upon which the surgeon may depend for guidance. One of the most important is relationship of the rate of flow of a liquid passing through a tube to the pressure the liquid exerts upon the walls of the tube or the "wall pressure." The wall pressure varies inversely as the velocity of the liquid. Narrow the tube at certain points and thereby increase the velocity and at these points the wall pressure is reduced. Dilate the tube in certain areas and there the wall pressure is increased. Thus, where an artery is narrowed, as by an end to end anastomosis, the blood exerts less strain upon the arterial wall. As an artery progressively dilates, as from an aneurysm,

the current through the dilated portion is slowed, but the wall pressure increases. Conversely if nothing retards the velocity of a liquid through a vessel, no pressure will be exerted upon the walls of the vessel. Indeed, under certain conditions, a negative wall pressure will be present. A thin rubber tube will carry water at a pressure of 60 kg. or more per square centimeter and will not be distended if the rate of flow is not impeded. Tie for example the wrist of a thin rubber glove over a high pressure water spigot. Cut off the ends of several fingers and turn on the water at full pressure. The glove does not distend, but rather collapses against the rapidly moving stream of water. There has been no reduction in velocity of the stream and no wall pressure. Attempt to reduce the velocity by tying one or more of the open fingers of the glove. As the velocity is impeded, the glove becomes distended and may soon burst. Ligate one of the larger arteries of the body. The current, despite the collateral circulation, is slowed or arrested, and the vessel tends to dilate both proximal and distal to the point of ligation. How frequently has a proximal or a distal ligation for an aneurysm precipitated the rupture of the sac. Even the Greek surgeon, Antyllus, in the second century seems to have appreciated this better than some of our modern surgeons, for not content

\* Read before the Pan-American Medical Congress, Mexico City, July 30, 1931.



with a proximal and distal ligation, he also opened the sac and obliterated it by packing. Philagrius evidently also realized

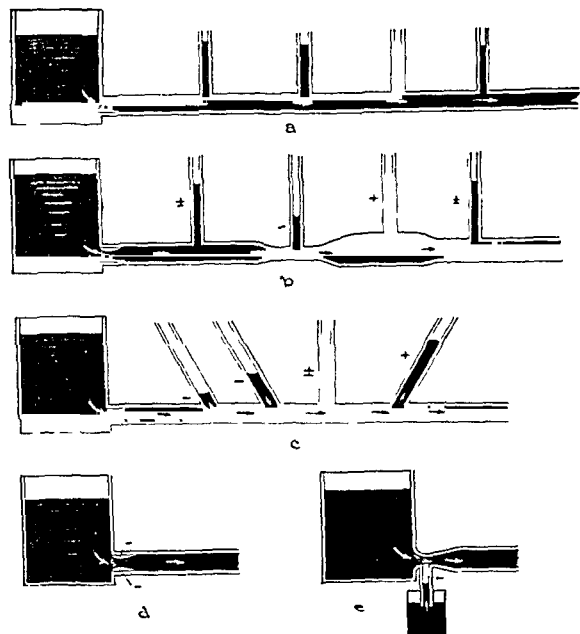


FIG. 1. Conventional diagrams illustrating factors that influence wall pressure from liquids flowing through tubes.

the inefficiency of ligation for aneurysm just as Percival Pott did in the 18th century.

Even the positive method of producing coagulation in an aneurysmal sac by wiring and electrolysis as devised by Moore and Corradi is a dangerous and uncertain method. Of 39 cases of aneurysm treated by wiring in the Johns Hopkins Hospital, nearly 50 per cent of the patients died in from one day to two months and none was known to be living at the time of Reed's report in 1926. From a hydrodynamic point of view it is evident that ligation or wiring for aneurysm is harmful. As slowing of the current of blood increases the pressure sustained by the vessel walls, we have turned to methods for increasing the flow of blood through the aneurysmal sac as the most feasible means of decompressing inaccessible aneurysms. For aneurysms of the thoracic aorta, we have divided the common carotid artery and internal jugular vein in the neck, and having ligated the distal ends have united the cardiac ends of the vein and artery. Thus, a bypass is provided, permitting the blood of the aneurysm to escape from the high pressure arterial system into the low or negative pressure of the descending vena cava. In other words, a constant arterial leakage is provided from the aneurysm and the adjacent

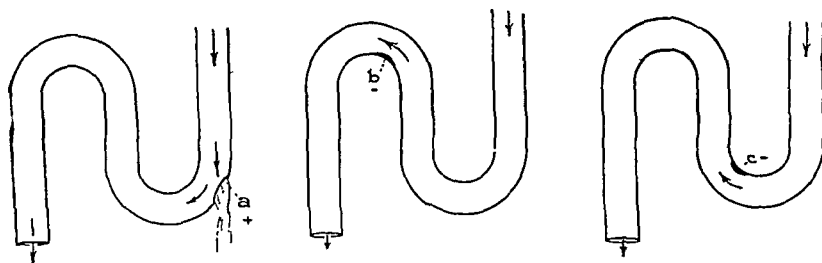


FIG. 2. Wall pressure from liquids flowing in tubes is reduced by increase in velocity or reduction in caliber of tube, and increased by reduction in velocity or increase in caliber of tube. At points of bending increased pressure is exerted on convexity, decreased pressure on concavity of tube.

Ligation for aneurysm, so often unsatisfactory, occasionally gives relief by causing thrombosis within the sac. The obliteration of an aneurysmal sac by thrombosis is, however, always uncertain; the clot rarely becomes organized and not infrequently melts down or gives rise to embolism.

vessels. Due to this leakage, the blood passes more rapidly through the aneurysm, the wall pressure of which is reduced. The systolic blood pressure falls, the aneurysm becomes smaller, the auricles of the heart fill in shorter time and by "the law of the heart" the rate is reduced. The pulmonary arteries carry partially oxygenated blood

and the respirations are slowed. The strain upon the arterial system both under excitement or repose is lessened and the

weeks from the progress of the disease. The operation was also tried on two patients for apparently hopeless types of heart

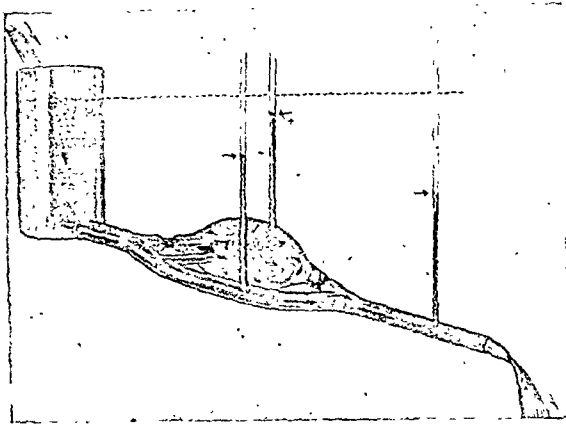


FIG. 3. Proximal and distal ligation for aneurysm reduces flow through sac; therefore, is followed by increased pressure upon walls of aneurysm, often leading to enlargement and rupture.

danger of enlargement and rupture of the aneurysm is decreased. This operation for thoracic aneurysm I first used in 1925. Since that time about fifty carotid-jugular anastomoses have been done by various surgeons. I have performed the operation nine times without operative mortality. In aneurysms of the aorta, there has been marked relief of pain. The first patient with an enormous aneurysm that had perforated the thoracic wall had a reduction in the diameter of the sac, was enabled to do light work and lived over four years finally dying of a chronic myocardial disease. The second patient after having been confined to bed by angina for eighteen months is relieved and is doing her housework; in the third, the aneurysm had perforated the posterior wall of the chest, yet the operation has also been followed by relief from pain. A recent fourth patient also shows improvement. In three other patients the operation was used to improve the pulmonary circulation in advanced bilateral pulmonary tuberculosis. One of these patients has shown marked improvement; two (Negroes) who were in the last stage of the disease made good operative recoveries but died after some

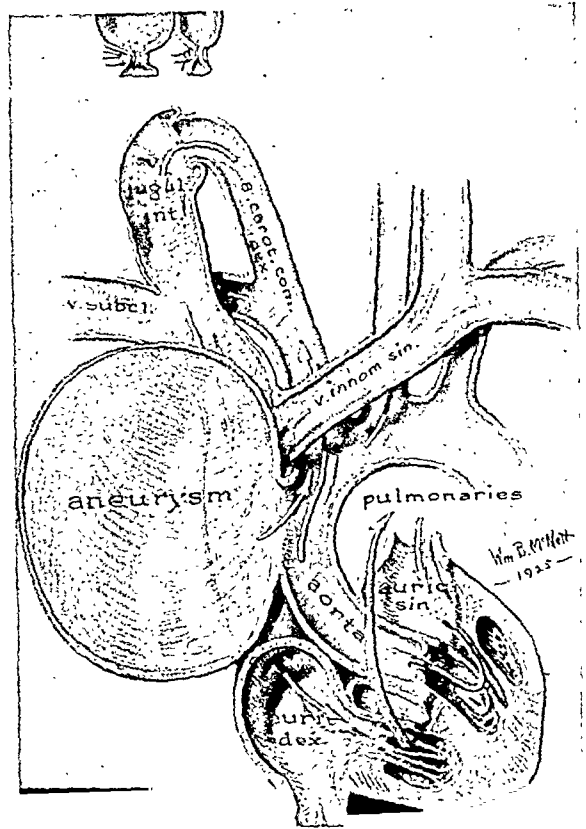


FIG. 4. Carotid jugular anastomosis for decompression of an aneurysm of the thoracic aorta. Artery and vein are divided, distal ends ligated and proximal or cardiac ends united, end to end, by suture. (From author's Text Book of Surgery. Saunders.)

disease. In a case of malignant endocarditis, little effect either favorable or unfavorable was observed. In a patient with chronic cyanosis from a supposed congenital stenosis of the pulmonary artery, the effects of the operation were masked by an advanced and widespread pulmonary tuberculosis.

It is believed that the operation has hydrodynamic merit in stenotic lesions of the heart and possibly also in cases of patent foramen ovale to balance the pressure in the right heart against that in the left. In mitral or pulmonary stenosis by increasing the velocity of blood through the heart, the output is increased. In angina the fall in aortic pressure may give

relief as was strikingly shown in the case of aneurysm, previously mentioned.

For intracranial aneurysms which may

clavian, the axillary or the iliac artery and the contiguous vein may be considered.

In any case, a lateral anastomosis be-

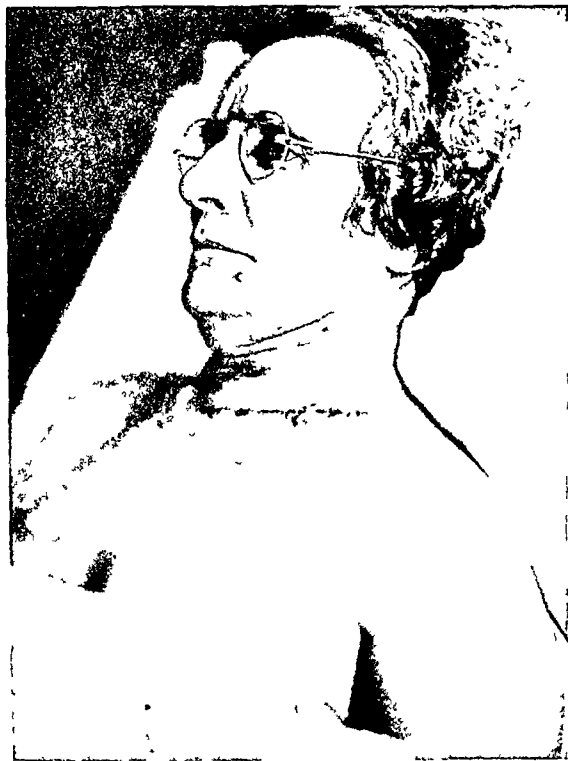


FIG. 5. Incision for carotid-jugular anastomosis. Aneurysm of descending aorta perforating ribs posteriorly.

temporarily improve under ligation and then progress to a fatal issue, we suggest a direct method of decompression by an arteriovenous anastomosis. The operation not only eliminates a large source of blood supply to the aneurysm, but also provides a large arterial leak from the aneurysm back to the heart. The common carotid artery and jugular vein, on the side of the aneurysm, are divided and the cerebral end of the artery is united to the cardiac end of the vein. The cerebral end of the vein and the cardiac end of the artery are tied. Experimenting for me on dogs, Burnett has found no evidence of cerebral degeneration after the operation. The highly skilled surgeon may select the less accessible internal carotid instead of the common carotid artery. For various aneurysms of the trunk, anastomoses between the sub-

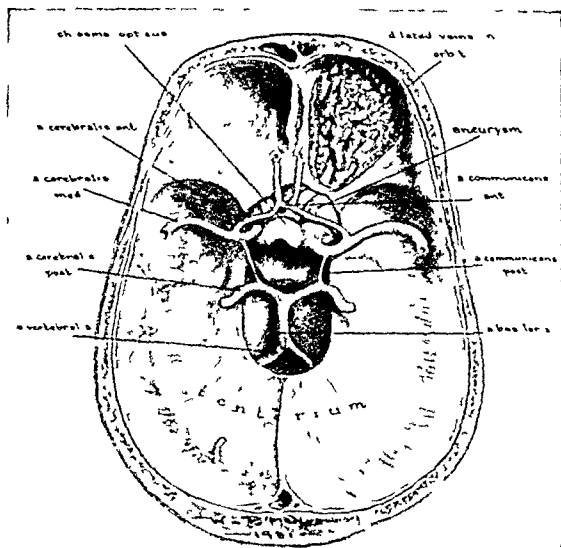


FIG. 6. Intracranial aneurysm with enlarged vessels of right orbit causing proptosis.

tween the artery and vein should not be used, as such a union produces very dangerous hydraulic effects upon the circulation. For example, the spontaneous rupture of a small aneurysm at the base of the aorta into the adjacent descending vena cava drives back the venous blood into the brain and so interrupts the cerebral circulation as usually to cause death in from seven to nine days.

Arteriovenous communications often follow injury, especially penetrating or gunshot wounds. In many cases, however, there is no history of an injury. The force of the arterial blood produces a distinct sac between the artery and the vein, or greatly dilates or elongates the veins forming an arterial varix. From the side to side communication, the arterial blood enters the vein, interrupts the venous current which is in part driven back toward the periphery especially during systole. During diastole, by the elastic rebound of the venous walls, venous blood may pass through the opening into the artery and by the succeeding systole be carried into the capillaries. The condition is associated

therefore with marked venous congestion and stasis in the affected veins and capillaries, and a mixture of both arterial and

arterial-venous fistula and returns to the body. The affected limb therefore is continuously being bled of its arterial

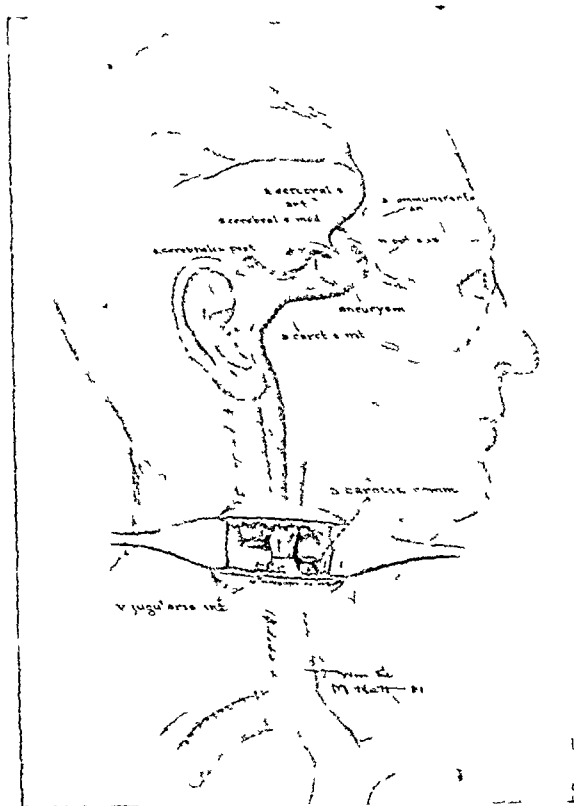


FIG. 7. Operation for intracranial aneurysm by carotid-jugular anastomosis. Cephalic end of divided carotid artery upon side of aneurysm is united to cardiac end of divided deep jugular vein. Cephalic end of vein and cardiac end of artery are ligated. Operation not only eliminates one large source of blood supply to aneurysm, but supplies a large exit under negative pressure for decompression and drainage of sac.

venous blood in both veins and arteries. The arterial blood tends to return to the body through the bypass and veins without going through the capillaries so that the nutrition of the tissues suffers. When an extremity is affected it becomes swollen, cyanotic, cold and often painful. There is widespread pulsation of the dilated peripheral veins. Pigmentation, necrosis, hemorrhages, ulceration and gangrene may occur. If the artery is ligated proximal to the anastomosis, the condition is made worse. Less arterial blood reaches the periphery, and through collateral channels the arterial blood passes through the

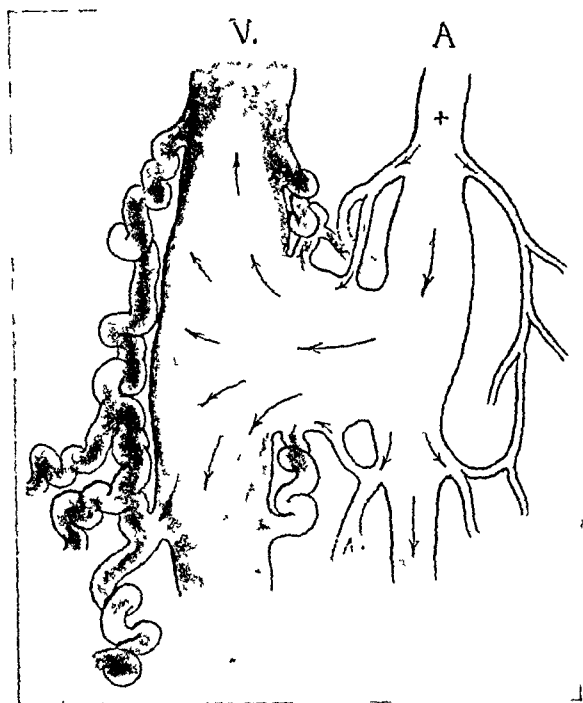


FIG. 8. Side-to-side arteriovenous communications produce great enlargement with pulsation of tributary veins. As indicated in diagram, during systole arterial blood enters vein, interrupting and reversing venous current.

blood. Ligation of the artery both proximal and distal to the fistula usually also fails to relieve the condition due to the very free anastomoses. After ligation of the artery and the vein, both above and below the fistula, the swelling usually quickly subsides, the ulcers heal and recovery follows. Only exceptionally does the quadruple ligation fail to block all collateral channels. A more ideal operation, when practicable, is to separate the artery and the vein and accurately close the opening in each with the removal of any intervening sac, or to resect the artery and vein at the site of the fistula, with an end to end anastomosis of each vessel. Such theoretically desirable operations may be very difficult or practically impossible. Matas has suggested that the fistulous opening be closed by sutures introduced

through an opening made in the vein, the incision in the vein being finally closed.  
In cirroid aneurysms greatly distended

ing of the arterial walls (arteriosclerosis), pressure from without (cervical rib, callus or tumor) or thrombosis or embolism

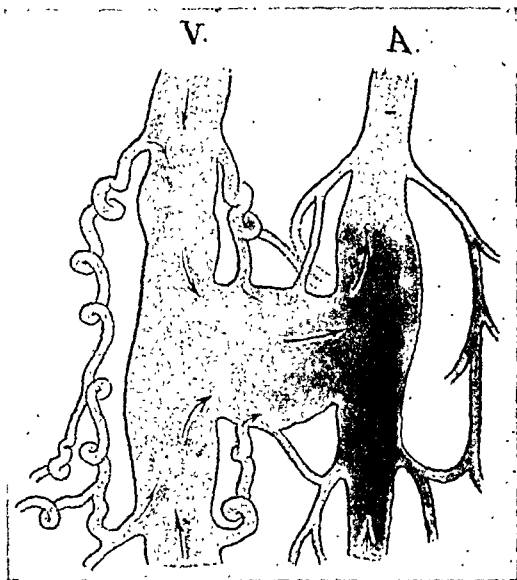


FIG. 9. In arteriovenous communications, during diastole, rebound of distended veins forces venous blood through fistula into artery, an added factor in reducing nutrition of part.

and pulsating veins occur from an arteriovenous fistula about the head. By excising the large vessels connected with the fistula, the condition is relieved. The location of the fistula may be determined by finding the point where the bruit is loudest and where pressure best stops the pulsation and causes collapse of the enlarged vessels.

Circulatory deficiency of the extremities may be due to vasomotor spasm, thicken-



FIG. 10. Areas of necrosis in leg of young girl from arteriovenous communication in thigh.

within the artery. A relative insufficiency may be due to venous engorgement (varicose veins) or cardiac disease.

In the spasmodic type of obstruction, such as occurs in Raynaud's disease, interruption of the sympathetic nerve supply by periarterial sympathectomy, ramisectomy or ganglionectomy is indicated. Of these operations, the periarterial sympathectomy is least dependable.

For types of partial obstruction, operations on the sympathetic system are occasionally useful and should be considered even in Buerger's disease, when the intravenous injection of typhoid bacilli or other test for vasospasm is followed by a marked rise in the temperature of the affected part. It is believed that undue credit has been given to periarterial sympathectomy from the improvement which so often follows in a limb with deficient circulation, when the patient is placed at rest in bed with the leg elevated. Especially is this true when a relative cardiac insufficiency is the precipitating factor. Under such a condition, a surprising but temporary improvement may follow the operation due entirely to a favorable influence upon the heart from the enforced post-

TABLE I

CIRCULATORY INSUFFICIENCY OF EXTREMITIES

1. CARDIAC	Myocardial, Valvular, Conductive .....	Rest, Recumbency, Digitalis, Quinidine, CO <sub>2</sub> -O <sub>2</sub> Thyroidectomy.
2. ARTERIAL	External Pressure.....	Remove Cervical Rib, Tumor.
	Thrombus, Embolus ..	Embolectomy.
	Vascular Spasm.....	Sympathectomy, Adrenal Denervation(?).
	a. Adventitia .....	Division.
	b. Media } .....	Development of Collateral Circulation: (a) Ligation or Occlusion of Veins. (b) Intravascular Injections.
	c. Intima } .....	
3. CAPILLARY.....		Radiant Light, Heat, Baths. Exercise. Increase of Blood Volume.
4. VENOUS .....		Recumbency, Support, Sclerosing Injections.

operative rest and position. In certain cases of partial occlusion of the arteries of the leg or arm relative compensation may be obtained by improving the output of the heart by regulated rest and the use of heart tonics.

In the treatment of the other forms of circulatory failure in the extremities, mechanical obstructions should first receive attention. A cervical rib should be removed or the scalenus anterior divided, as suggested by Adson. Tumors should be excised. Embolectomy has in a small percentage of cases been successful and should be considered at the onset of thrombosis. The toxic causes that produce arterial occlusion, especially tobacco, lead, syphilis, should as far as possible be eliminated.

An increase in blood volume seems often to give a degree of relief. Marked improvement has followed the use of intravenous injections of physiologic saline, hypertonic saline, sodium citrate solution (Steele), sodium iodide solution, and other liquids. It is quite possible that the added bulk of water introduced into the circulation deserves especial credit.

In Buerger's disease and in arteriosclerosis improvement of the collateral circulation is most desirable. The ligation of the main vein of the limb often seems of value in causing an enlargement of the collateral vessels.

Oppel of Petrograd has long contended that an adrenalinemia which causes an exfoliation of the endothelium of the arteries is responsible for the thrombosis of endarteritis obliterans and has urged as an appropriate treatment a reduction in the functional activity of the medulla of the suprarenal by operation. The operation of denervation of the adrenals now being used by Crile for other conditions we therefore have tried for Buerger's disease. A wider experience is required however, before any conclusion is reached.

Vascular anastomosis for the relief of circulatory deficiency of the extremities has thus far failed to improve the condition. An end to end union between the central ends of the main artery and the peripheral ends of the vein does not improve the circulation. The arterial blood in a measure drives back the venous blood toward the periphery, but unfortunately the arterial blood soon returns to the body by collateral veins without passing through the capillaries of the limb. The operation is therefore harmful.

The effects of a lateral anastomosis between the main artery and vein of the limb are, as has been indicated, also harmful. Necrosis and gangrene usually rapidly increase after such an operation which even fails as a temporary method of improving the collateral circulation.



# TRANSURETHRAL CORRECTION OF PROSTATIC OBSTRUCTION\*

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THERE is probably no operation in surgery which has done more to relieve suffering humanity than prostatectomy. The success attained in relieving those suffering from urinary obstruction has caused a large number of men past middle life to sacrifice their prostate gland as a ransom for freedom of urination. In spite of the improvement in surgical technique, the marvelous improvement in the preoperative preparation of patients, the special attention given to decompression through drainage, and the improvement in the various laboratory methods for determining the proper time for operation, this operation with its potentially high mortality and morbidity rate has not fulfilled the ideal. The success of prostatectomy is so generally accepted by the profession that relief by removing, by a minor operation, only that portion of the gland that is causing obstruction until recently has received indifferent attention, except by a few surgeons.

One has only to review the literature to observe the array of splendid devices and procedures that have been advocated for the relief of vesical orifice obstructions, which is sufficient testimony to the eagerness to substitute methods of simplicity for the former orthodox measures with its complications and dangers.

As early as 1830, Guthrie devised an instrument and described his operation for the correction of certain bar obstructions of the vesical neck. Civiale and Mercier later devised instruments and laid claims for the operation. Bottini in 1874 introduced his cautery incisor. Freudenburg in 1897 and Chetwood in 1901 modified the Bottini instrument. The

inability to visualize the operative field during the operation resulted in numerous failures and accidents that caused the instrument to fall into disrepute.

Renewed interest was directed to this phase of urology when Young in 1909 presented his punch instrument with a report of excellent results in certain selected cases. As adequate provision for hemostasis was not provided, the extensive removal of tissue was not possible and a warning was given against the use of this instrument in adenomatous hypertrophy.

Caulk in 1919 presented his cautery punch in which the use of the cautery blade to section tissue and reduce hemorrhage permitted the operator to remove more tissue. Undoubtedly he was the first to obtain satisfactory results in other than bars and contractures.

With the advent of the various high frequency currents used in the field of medicine, new impetus was given to this type of operation.

Collings in 1926 reported the sectioning of bars and contractures by means of a high frequency electric current with suitable electrodes through the panendoscope under vision with a lens system. He was insistent that his procedure be limited to bars and contractures of the vesical orifice. The same year, Maximilian Stern presented his ingenious instrument, which he termed the resectoscope, and to him must be given the credit for the invention of an instrument that is superior to its predecessors.

In 1930 Kirwin introduced his resector, using an electrode to coagulate and render the tissue hemostatic prior to its removal by a rotating knife. During the present year, McCarthy has adapted the principle

\* From Crowell Clinic of Urology and Dermatology, Charlotte, N. C. Read before the New York Society of the American Urological Association, January 27, 1932.

of Stern, using a cutting loop through a specially constructed panendoscope with which he has had remarkable success in remodeling the prostatic urethra.

Numerous others have made improvements or modifications of the various instruments that have been introduced to the profession; the ones outlined constitute a résumé of the more important contributions.

In 1927 the author began the journey into the wilderness, following in the pathway blazed by Stern, until the trail terminated and it was necessary for progression to hew his own pathway onward to the summit of idealism. The peak has not been attained, but progress has been made.

The operation as presented by Stern was described as being bloodless; this was found to be exaggerated. There was no provision for the control of hemorrhage should the occasion arise. The presence of hemorrhage greatly prolonged the procedure and limited the amount of tissue that it was possible to remove. I have made numerous changes in the original instrument, enlarging the length and depth of the fenestrum, increasing the illumination, perfecting the loops to such a degree that they render adequate service under the most adverse conditions and perfecting an arrangement that permits the sectioning of tissue and rapid hemostasis, that allows the most extensive removal of tissue during one sitting.

Any form of electrical current, direct, alternating or high frequency, when of the proper voltage, amperage and continuity of energy application will give the so-called electrical cutting of tissue. Commercial electric current cannot of course be used in surgery on account of the chemical changes or violent contractile effects produced by the low period of alternation. Therefore high frequency currents are used, which on account of their rapid rate of oscillation of current flow (at a rate of upwards of a million oscillations per second) are without electrochemical action and practically free from neuromuscular re-

sponses, even though heavy amperages be used.

The character of the different high frequency surgical currents employed varies immensely and different types of current produce radically different results. Generally speaking, there are two types of high frequency currents, either damped or undamped. An undamped current is one which alternates in direction of flow and substantially uniform rate of amplitude. A damped current is one which varies periodically in rate as well as amplitude. An undamped or continuous wave current flows with practically a continuous application of energy, whereas a highly damped current consists of recurrent bursts of energy or electrical discharges of considerable intensity but of short duration with long periods of inactivity between wave trains.

These two fundamentally different types of high frequency current distinguish basically between the so-called cutting and coagulating currents. Therefore the fact that a current is of high frequency does not necessarily suit it to electrosurgery. A pure, undamped or continuous wave current, although it has excellent cutting qualities, offers practically no advantages over the ordinary cold blade punch operations, as it has very little dehydrating or coagulating effect (with consequent hemostatic properties) on the severed edges of tissue, which is one of the chief factors desired in prostatic resection.

On the other hand, a highly damped current will desiccate or coagulate tissue, but has absolutely no cutting ability. A moderately damped current has the characteristics when applied through the proper electrodes of creating a small, though intense arc at the point of contact between the cutting electrode and tissue; dissolution of the tissues in the immediate path of this arc takes place and they are severed as though actually cut. The electrode severs tissue as readily as the sharpest scalpel, and there is little if any mechanical resistance encountered as the cutting



electrode passes through. Moreover, the intense heat generated at the point of contact dehydrates the severed edges of tissue and they present a thin depth of dehydration (or combined zone of dehydration and coagulation), which seals off the capillaries, lymph ducts, and smaller blood vessels, thereby preventing bleeding and oozing from these sources. The depth of this zone of dehydration depends not on the voltage or power of the cutting current, but on its characteristic or wave form, as previously pointed out.

The Davis-Bovie electrosurgical unit is constructed in two entirely separate sections within one cabinet. The cutting section is constructed to produce a current of moderate damping which has been pointed out as being the ideal current that has the peculiarity of sectioning tissue with a minimum of hemorrhage. The other or coagulating section produces a highly damped current which has no cutting qualities but is ideal for the rapid coagulation which is at times necessary for hemostasis. Each of these sections is an entirely separate electrical circuit with individual controls and adjustments. An electromagnetic selector is provided which instantly connects either current to a common outlet through the operation of the proper treadle of a double foot switch.

The perfection of the instrument and application of suitable electric currents permits the removal of sufficient tissue with adequate hemostasis under vision, permitting the correction of many obstructions that were formerly considered amenable only to complete enucleation of the gland. During the past five years, the writer has operated upon cases of various types of prostatic obstruction with uniformly successful results.

The fundamental principle in this problem is the removal of the obstructing tissue, either by excision or destruction or a combination of these, sufficient to relieve the obstruction with a minimum of injury to the surrounding parts. Equally important is the restriction of complications and

the adequate control of hemorrhage. With the present equipment, it is possible to relieve more than 90 per cent of the cases with an operation that is simple, wherein the risk is negligible and the final results are equal if not superior to those obtained by prostatectomy.

All operators are familiar with the marked shrinkage that regularly occurs in the enlarged prostate following the preliminary cystotomy drainage prior to subsequent enucleation in the two stage prostatectomy. Since the prostate diminishes in size with the removal of the residual through a cystotomy incision, the same shrinkage follows the adequate drainage instituted through removal of the tissue that is impinging upon the vesical neck and posterior urethra. When this can be successfully accomplished through trans-urethral resection, the indications for more radical surgery vanish, for few patients will submit to a prostatectomy when a minor procedure will permit them to void freely and completely empty their bladder.

Regardless of the type of obstruction or the operation that is to be performed, it is of paramount importance to prepare these patients properly by thorough decompression with a retained urethral catheter. A careful watch should be maintained of the nitrogenous constituents of the blood; the renal function should be stabilized and the correction of other constitutional abnormalities should receive appropriate consideration. It is only by adhering to these well-known surgical principles that maximum results with a minimum mortality rate may be obtained.

The cases treated by resection have had the usual complications concomitant with age and obstruction, varying with the age of the patient and the degree and duration of the obstruction. The frequency, difficulty, dribbling, retention, incontinence and the general symptoms of uremia and circulatory embarrassment have been identical with those reported by surgeons who have resorted to enucleation for a cure.

The residual urine in this series of cases has varied from none at all to 48 ounces with complete retention. The amount of residual urine is not a criterion to the amount of obstruction present. In some patients without residual urine, large bilateral and middle adeno-fibromatous hypertrophy was found; in others, with complete retention, only a small bar or median lobe was found to be causing the obstruction.

TABLE I

## ANALYSES OF CASES OPERATED UPON BY RESECTION

Contracted vesical orifice.....	21
Median lobe or bar.....	87
Unilateral lobe.....	8
Unilateral and median lobe.....	39
Bilateral lobes.....	58
Bilateral and median lobes.....	62
Carcinoma.....	40
Following previous prostatectomy:	
Perineal.....	9
Suprapubic.....	14
Recurrences, median lobe resected 1929	
Lateral lobes resected 1931.....	1
Total.....	339

From Table I it will be observed that practically every type of obstructing gland has been operated upon by this method. During the past year 158 obstruction cases have been operated upon by resection, while only 12 have been operated upon by prostatectomy.

The amount of tissue that was removed varied from 1.5 gm. in the contractures and small bars to 45 gm. in the larger types of hypertrophy. It is frequently surprising to note the small amount of tissue removed in patients with complete retention and the resulting freedom with which they completely empty their bladders.

Eleven of the patients operated upon during 1927 and 1928 required a second operation within six months, as sufficient tissue was not removed at the initial operation. In 2 of these cases, failure in the equipment before completion of the operation caused a discontinuance until a later date. The other 9 were due to the inability to remove sufficient tissue during the length of anesthesia, with an equipment that was

far inferior to that in use at the present time.

Two cases during the present year have required a two-stage resection; one of these was elective, in the other the anesthesia was of insufficient duration to permit the removal of all obstructive tissue.

The average stay in the hospital after operation has been four days; 3 patients remained two weeks; 18 one week, while all others have been dismissed within three to five days.

There has been only one recurrence; a patient in which the median lobe was resected in 1929. The lateral lobes at this time were not enlarged. He returned in October 1931, with complete retention due to large bilateral hypertrophy. The lateral lobes were resected with excellent results.

You will recall that 23 of the cases reported in this series had been subjected to a prostatectomy within five years prior to their admission for resection, in which a definite recurrence was found. Approximately the same number of patients have had a resection as have had a prostatectomy in the same geographical area within the past five years, with a recurrence morbidity of 23 to 1 in favor of resection. I, therefore, think that it is incumbent upon the prostatectomists to prove their logic that the incidence of recurrence will be greater in resection than after prostatectomy.

## HEMORRHAGE

One of the chief difficulties with trans-urethral procedures has been in the proper control of hemorrhage. The current supplied by the Davis-Bovie electrosurgical unit sections tissue with practically no hemorrhage during the operation. The highly damped current also available and the technique to be described should the occasion arise permits of rapid and effective hemostasis. There has been one case of hemorrhage in a patient with a carcinoma that involved the left lateral wall of the bladder which required cystotomy for its

control. The operative site was free from hemorrhage and obstruction.

Two cases of secondary hemorrhage have occurred; one on the tenth day, the other on the fourteenth day. Both of these cases were easily controlled by coagulation through the urethra. Blood clots may be so easily evacuated from the bladder with the author's cystoscope curette and coagulation of the bleeding vessel is so readily accomplished that secondary hemorrhage, if it should arise, is of minor importance.

One accident has occurred; a patient sixty-eight years of age with very large bilateral and middle lobes with a small diverticulum in the posterior bladder wall had a marked bronchiectasis with paroxysms of coughing, with a nervous disposition and continued grunting. During the beginning of the operation with the bladder well filled, a paroxysm of coughing caused an intraperitoneal perforation of the diverticulum. Immediate suprapubic cystotomy and drainage of the peritoneal cavity was induced. Ten days later the prostate was removed suprapubically with uneventful and complete recovery.

#### INFECTION

As the lymph channels and blood vessels are sealed by the dehydration incident to hemostasis, postoperative infection has been of negligible frequency. The temperature elevation has varied from normal to 104°F. Fifteen per cent of the cases have had some elevation. The fever has not persisted longer than one week in any case. A chill preceded the fever in 18 cases. The temperature elevation has been lower as a rule in those patients that have been on preliminary drainage with a retention catheter and have developed an immunity. Eight cases of epididymitis have occurred, all subsiding without interference.

#### CARCINOMA

Forty patients have had carcinoma; 4 have died of carcinomatosis without recurrence of the obstruction. One of these lived three years and nine months after the

operation. All others are living and free from obstruction.

#### MORTALITY

There has not been a death immediately following resection. In one patient with a very bad cardiac lesion and very large bilateral and median lobe obstruction, the passage of the examining cystoscope produced excessive hemorrhage. The resectoscope was employed only to control the bleeding. The patient left the hospital in three days, but succumbed to his cardiac condition three weeks later. I do not believe that the instrumentation hastened his demise. Another patient with a coronary sclerosis was dismissed from the hospital in four days after the operation; was up and about feeling fine without urinary symptoms when he suddenly died in an attack of angina pectoris two weeks after the operation. A third patient was dismissed from the hospital in good condition. While at his distant home a slough from the coagulated site caused a complete retention and at his return to the hospital he showed an hemorrhagic nephritis which eventuated in an uremic death three days later and three and one half weeks after the operation.

#### RESIDUAL URINE

The vast majority completely empty their bladder following the removal of the retention catheter. There has not been a case with over 2 ounces of residual urine at the time of primary dismissal. Upon a return for a recheck examination this residual has been reduced to less than one ounce in every case. After sufficient time has elapsed, shrinkage of the gland has been noted and the residual urine has disappeared.

#### DISCUSSION

DR. JOSEPH F. MCCARTHY: In discussing Dr. Davis' paper of this evening, it may be of interest to quote the conclusions incorporated in a paper of mine published nineteen years ago, entitled "Preliminary report on cystoscopic

intravesical prostatic intrusion and other obstructing conditions in the region of the vesical sphincter."<sup>1</sup>

"The preceding chapters patently emphasize the very great importance of early diagnosis, years earlier than is at present the rule, diagnosis made before profound structural secondary changes have taken place. When one considers that the average wide-awake practitioner now regards the estimation of the blood pressure of his patient as an integral part of his routine physical examination, does it not seem plausible that a properly conducted campaign of education on the part of urologists would sufficiently stimulate the interest of medical men by directing their attention to the importance of routine inquiry into the condition of the genito-urinary tract, particularly of patients over fifty?

"I would minimize the importance of rectal examination and emphasize the necessity of estimating at a number of sittings the amount of urine remaining after the patient empties his bladder as thoroughly as possible. I would also point out the imperative necessity of early cystoscopic and posterior endoscopic examinations of patients showing any appreciable amount of residual urine, and symptomatically giving evidences of the likelihood of prostatic disturbances. As it is at this time particularly that these patients will, in all likelihood, prove amenable to suitable cystoscopic treatment.

"If heed therefore be accorded the message conveyed in this communication, it may not seem unreasonable to anticipate an earlier and a more effective means of combating this sinister obstacle to many a 'ripe old age.'"

Later in conjunction with Mr. Reinhold Wappler we experimented with a wedge-shaped electrode, and still later with loop electrodes identical with those now in use. As a result of these experiments we came to the conclusion that the electrical and optical equipment of those days were not equal to the exacting demands of so highly technical a procedure as endoscopic revision of the prostatic encumbered urethra.

My interest was again renewed in this fascinating study by the work of Caulk and Davis, together with the impressive case reports emanating from their respective clinics, and at my suggestion Mr. Frederick Wappler undertook the research which resulted in the present

cutting and coagulating machine, which adequately meets the exacting requirements set forth by me as necessary prerequisites, before any attempt should be made in the construction of endoscope and cutting loops, designed to carry out the actual operative steps.

In the approach and objective of Dr. Davis and other workers in this field, as I interpret them, there is a wide divergence of opinion from my own, which is as follows:

The rationale of the method is, or at least should be, the removal of as much of the obstructing prostate as in the experience and judgment of the operator seems necessary. This, it seems to me, because of the age and the accompanying disability of the patient, should be carried out in as brief a time as possible.

Time alone will determine the amount of tissue removed. This will always, however, be regulated by individual case requirements. It is our present belief that the lateral lobes play a relatively minor role in urinary obstruction, and that the major role is largely the result of infiltrative or glandular distortions on the floor of the bladder neck and deep urethra, and it is because of the resultant loss of elasticity that the neuromuscular mechanism is not equal to the job of depressing this floor as it is normally done during the act of micturition. For these reasons we cannot subscribe to the opinion expressed that a large cavity simulating that following prostatectomy must result. This observation is likewise confirmed clinically not only by us, but also in the hands of others, notably Engel of Crile's Clinic.

The operative field should be under the most precise and comprehensive visual control.

The cutting loop should have sufficient flexibility to enable the operator to effect a deep incision where the intrusion is most pronounced and the factor of safety greatest and as superficial as desired, in the region of the veru montanum, where it is least.

The cutting loop should be drawn through the prostatic tissue very slowly, taking about twenty seconds for its complete excursion, so that it will coagulate the tissue as it cuts. This coagulation should, however, be as superficial as is consistent with adequate hemostasis.

Upon removal of the wedge-shaped cast, the oozing points are visualized and gently coagulated *under vision*. This coagulation must be localized to the precise bleeding point, to the end that but islets of coagulated tissue remain.

<sup>1</sup> AM. J. SURG., September, 1913.

These small points of coagulation, together with the very superficial coagulated trajectory of the incised area, logically predispose to early urethral convalescence, which is quite different from hospital domicile. By this procedure the rapid epithelization should and does eventuate. The possibility, also, of late secondary hemorrhage as well as fibrous tissue replacement is thereby rendered the more remote.

The question of hemorrhage is at present the high point of controversy, though I here predict it will not remain so for very long.

If the complete arrest of oozing automatically implies extensive, deep-seated or indiscriminate coagulation, it might very well be questioned if the cure is not worse than the complaint. Certainly this method of control carries no appeal to me.

If endourethral prostatic surgical intervention is to leave behind as its terminal step a cooked urethra, we had better rely on prostatectomy.

In our service at the Post-Graduate Hospital, in well over 100 cases treated by my associates and myself there were but 3 cases in which it was necessary to re-introduce the panendoscope, evacuate the clots, visualize and coagulate the bleeding points. These patients convalesced uneventfully.

Quite recently I encountered a case where the prostate was malignant and it was necessary to introduce via the urethra a Ballenger bag. This worked out so successfully that further study has convinced us of the complete feasibility of this procedure. Small bags have been made in our clinic which may readily be introduced through the sheath of the instrument, the latter withdrawn, and the bag then filled with 40 or 50 c.c. of water, and then gently drawn into the prostatic urethra. A variety of types of these bags, with and without accompanying catheter, are under construction at the moment. In our hands these are more a mental solace than an actual need. With our improved technique, their employment will be rare indeed.

My interpretation of the procedure as a whole is that we are dealing with a tubular structure into the lumen of which are projected irregular distortions of pathologic prostate, most of which extends in the long axis of the canal. This calls for the removal of the obstructing tissue in the form of tubular, or preferably wedge-shaped casts. These casts naturally are

best removed by a loop-shaped cutting appliance. In effect, these encroachments on the tube which, because of the facility of their removal with this new electrical apparatus may be considered as so much plastic material, would I submit be removed by an artist in a manner somewhat similar to the method as herein advocated.

Certain it is, the fenestrated type of instrument, with its restricted visual field and the necessity of forcing the tissue into this fenestrum as a necessary preliminary to its removal, is neither logical nor practical; and except in the hands of men like Dr. Davis will not enjoy general usage.

This revolutionary procedure with its attendant spectacular successes is big enough and promising enough to merit our philosophical, our dispassionate consideration. We should, insofar as it is humanly possible, submerge individualistic ego; there is glory enough for all concerned. If I have evidenced even a trace of dogmatism in this discussion, it has not been by design. If evaluated (as I trust it will and should be) it will be regarded as an effort to provide a discussion worthy of the brilliant work of Dr. Davis, and the long journey he has made to further acquaint us with his work and that many others of our colleagues have made to see and hear us.

DR. THOMAS J. KIRWIN: Dr. Davis has described his method of prostatic resection by the urethral route and we have also heard another method described tonight, both striving for a common result. I shall confine my brief discussion to the mechanical and electrical aspects of each.

No matter what instrument may be employed, work upon the bladder neck requires the utmost operative precision. The Stern instrument possesses certain mechanical features which demand the exercise of considerable skill on the part of the operator. Yet there are advantages available today unknown when the Stern instrument was designed, and these the skilled operator should not overlook.

Of primary importance is the cystoscopic picture obtained. The McCarthy telescope cannot be surpassed for this purpose, and is the basic factor in any method of bladder neck resection. This will have been forcibly impressed on any one who has had opportunity to use both the instruments under discussion. The direct type of telescope with which the Stern

is equipped does not afford so accurate a picture as that obtained with the McCarthy. With the direct-telescope instrument, one sees but a single aspect of the bladder neck; while with the McCarthy, inspection is made from the angle affording the best and most comprehensive view. A number of observers have noted that the direct telescope, on this account, gives a misleading view of collar conditions even in a normal bladder neck.

Visualization of the cutting loop in the McCarthy electrome is complete; motion of the loop is toward the operator, and both ends of the cut are constantly in view under full illumination. The position of the loop in the open-ended sheath permits a freedom of manipulation and an accuracy of application heretofore unobtainable. This, as you all know, is not true in the Stern, as the loop is usually pushed away from the operator and cannot be seen after engaging the tissue.

In regard to the cutting unit: it will be long indeed before the McCarthy apparatus finds its equal in cutting ability and splendid coagulating effect. It is surely another triumph for urology that our specialty has once again given to the world of surgery and medicine a modality of untold importance. Years will probably pass before all the potentialities of the new type of current will be fully appreciated.

All who are interested in vesical neck resection must realize that this unit is a culmination of the efforts of a small group of men who have devoted years of experimentation and research to it. The instrument and the electrical apparatus had to be developed side by side. The benefit of the experience and efforts of these men has been made freely available to us, and we should accord them full appreciation for the vast amount of time, energy, and money they have expended. I wish to take this opportunity of congratulating Dr. McCarthy for placing on a practical and time-saving basis this new method of the treatment of prostatism.

Criticism, to be helpful, must be constructive, not destructive. We should display an intelligent appreciation of what others have done, instead of heaping wholesale condemnation upon their accomplishments, often without sufficient investigation to discover whether or not their methods possess merit. Though we may not all agree as to the value of electroresection, it is most satisfying to see how open-minded the majority of leading urologists are

regarding it. Dr. Lowsley does not share my personal enthusiasm, yet he has gladly placed at my disposal all the facilities of his department and is turning over a series of cases for investigation, thereby granting me every opportunity to demonstrate its scientific value.

The entire question as to the employment of electroresection in urologic work is now being freely discussed, and, no matter what our personal prejudices, we should retain the open-minded attitude in regard to it. There is an old aphorism which says: "Give me the radius of a man's tolerance and I will show you the circumference of his intelligence."

Since 1923, I have relieved some 700 patients with prostatic obstruction by transurethral surgery at New York University, Bellevue Hospital, and in private practice. There have been no operative deaths; I have not had to open the bladder suprapubically for bleeding.

From 1923 to 1926 I recommended transurethral surgery for prostatic bars, scars following prostatectomy and obstructing carcinomatous bars. During this period I attempted to relieve benign enlargement of the prostate. Using the tube set, the radiotherm, primary bleeding often interfered with vision. The efficiency of the current only permitted the removal of small sections of the gland, and I felt that whittling away for an hour or two produced too much instrumental trauma. I was able, in most instances, to reduce the residual urine with the knife or loop electrode; but I felt it would be wiser, in benign hypertrophy, to do a prostatectomy.

Shortly after this a spark gap machine, the electrotome, was developed. This unit proved more efficient, but not efficient enough to excise a moderate or large lateral or median lobe obstruction. It was found that the machine would heat up after using it for thirty or forty minutes. "Sputtering" occurred at this point, and the cutting power was diminished. Hence the relief of a typical benign enlargement of the prostate was again precluded.

However, there are certain patients with prostatic obstruction who refuse or are refused prostatectomy. From 1927 to 1931 I operated upon 20 such patients. Nine had refused prostatectomy; in 6 cases the referring doctor requested transurethral surgery; 4 had serious heart lesions, and one diabetes. By cystourethroscopy, this group showed a bar plus slight lateral lobes, intraurethral lobes or

median lobes. Half of these patients had a residuum of 60 to 120 c.c., the remainder 180 c.c. to complete retention. After operation they all emptied their bladders and were relieved of their symptoms save 3, and they retained 7, 10, and 15 c.c. respectively. Of special interest is W.G., aged seventy-one, referred by Dr. Keyes in March of 1927. One month previously, Dr. Keyes had done a litholapaxy. I excised a bar and intraurethral lateral lobes. It is now approximately five years after operation, and the patient empties his bladder without symptoms.

Desiring a more powerful spark gap cutting current, I suggested my requirements to the High Tension Corporation during the College of Surgeons Congress in Philadelphia in 1930. Since then their engineers have developed a supercutting current which not only cuts through tissue quickly and easily, but coagulates at the same time. The character of the current allows this very necessary factor to take place. In the spark gap machine, there is a time period between the high frequency oscillation cycles. Coagulation takes place during this pause.

In the tube type machine the high frequency oscillations are continuous, with no pause between the cycles; hence the coagulation is not very efficient, and important bleeding sometimes follows:

I have been using the high tension apparatus for the past several months with entire satisfaction. I have been able to excise as little or as much of the prostate gland as desired. One can almost say, "What used to take hours, can now be done in minutes." Here again I have had no important primary or secondary bleeding. The cutting apparatus is so powerful that I have not had the courage to open up the "throttle" beyond half speed. I employ Reinhold Wappler's No. 28 French bakelite sheath (to prevent short circuits) and a rather large loop electrode bent at a right angle with the long axis of the electrode. To complete the outfit, the author's cystourethroscope telescope, or panendoscope telescope, fit perfectly in the bakelite sheath.

I have been extremely pleased with my results thus far. The patients have been relieved of a serious lesion without surgical shock, and without the one complication that brings disrepute to transurethral surgery, namely, hemorrhage.

DR. ALEXANDER RANDALL: I have not had the privilege of seeing Dr. Davis operate; but I have been asked to discuss his work before. Looking back on it, I realize that I was sensibly anxious as to its value, and always kept before me one idea, i.e., are we in performing a prostatectomy doing more than is necessary? And is the time coming when partial removal of obstructing tissue will be found to be all that is required?

Tonight I have heard no mention made of two phases of this subject. One is why a patient with hypertrophy has residual urine. I think Dr. McCarthy has created a new point of view in speaking of the advantages of canalization of the prostatic urethra. Probably the essentially correct viewpoint to take of prostatic obstruction is not so much one of the existence of obstructing hypertrophied tissue, as of the prostatic capsular tension. And if by canalization the relief of tension is obtained, I am of the opinion that in a proportion of cases relief of residual urine will also follow. The question in my mind (which of course must await the judgment of time) is whether or not one can obtain a permanent result by this method.

But there again we have a second point: Is it not perhaps better to subject an elderly man to two minor procedures than to do more than is necessary?

I have heard exaggerated views on this question of hemorrhage. I do not quite know why others fear it so. I grew up in my early urological life in close association with Young's punch and I became, and I am afraid I still am, rather callous to hemorrhage. Granting that it can be of serious moment, on the other hand think how often we paid little or no attention to what might be called serious bleeding following the punch operation. I rather feel that it is neither the whole story, nor a matter of deep concern, nor impossible of control by mechanical means.

I am in sympathy with Dr. McCarthy's remarks as to the inadvisability of the unskilled operator using this method. One cannot expect this instrument, or that, to work like a graphophone, i.e., just by putting a needle in place, turning a switch, and so making a surgeon of anyone who has the money to buy the type of apparatus. My experience with various machines of this type has convinced me that they can all be made to do the work. But it is not easy work; it is highly technical.

This brings up another point not mentioned this evening, the matter of some standard of guidance as to when the operation is finished. I noticed that the title of Dr. Davis' paper was not "prostatectomy," but "relief of prostatic obstruction." I am convinced that prostatectomies will never be done by instrumental methods. But again I return to the original point: When will we be able to say it is not necessary to do gross surgery, and when will we learn the limits to which we must go to relieve a patient?

The happiest point of the evening is the look into the future that it gives us. I see in this method the complete obsolescence of the punch operation. Tonight it is ended! And I see in the future another factor, referred to by Dr. McCarthy, the early handling of prostatic obstruction, the control of what we might call the "preprostatic" and the preservation of normally functioning organs, rather than the correction of obstruction after gross destructive conditions have developed. When we can do that, we will be preventing that sequence of events we are all familiar with, the destruction of the bladder's muscular function, the development of diverticula, the effects of back pressure conditions on the kidney, cardiac damage, high blood pressure, etc.

In other words, I think we can begin to see that in the future we can take a number of patients to the operating room before damage is done. And we may even enter that Utopia of Medicine where we can apply ourselves to preventive surgery.

DR. OSWALD S. LOWSLEY: The urologists gathered here always welcome any promising new instrument, or any new series of instruments, or instrumental methods, because the only difference between a good urologist and a good general surgeon is that the modern urologist is a good general surgeon who has instruments of precision and knows how to use them.

It seems to me that the most outstanding work of the last decade is this work. It overshadows uroselectan, which was rated (and should be) as a real contribution to urology.

One thing is certain, that the type of operation described by Dr. Davis this evening has quite properly ended the punch operation. Though there has been a time in this city when punch operations were not nearly sufficient in numbers. The Young punch was the

only instrument we had at one time. There were accidents; there will be with every type of instrument. Dr. McCarthy has been honest enough to admit a death. There have already been many with this new type of procedure. I know of one in Brooklyn, and two out West. But the fact that there has been an occasional death does not give the method a black eye. A clinic such as ours cannot afford to dismiss an idea like this without trial. All of the members of my staff are young. We cannot allow their minds to crystallize. Therefore I have given Dr. Kirwin a free rein to his enthusiasm. He will do a series using this new method.

While I grant that it requires skill, this is not a trick operation. Both Drs. Davis and McCarthy would be the last to say that it is to be restricted to only a small group of experienced men. It can be done successfully by those with a moderate ability. I know, because I have done it several times myself.

I cannot help but feel that canalizing a prostate with a large adenoma is a decided mistake. I hate to put any fly in the ointment; but that is my firm opinion, and has been from the beginning. If that belief is wrong, I am willing to be shown, and to admit I am wrong. But this procedure seems to me to be in the same class with the old Sleuter method of tonsillectomy. If these patients live long enough with a considerable portion of the prostate left in, they will return for prostatic removal, or another operation of the sort. This may be desirable; but at present I do not think so. After the enthusiasm of the pioneer has subsided, somehow I feel that although there will be far larger numbers of patients operated upon by this new technique, they will not be the fullblown adenomatous prostatitics, but the borderline cases. Dr. Randall seems to have put it very nicely by saying that preventive medicine may enter at this point.

I am under the impression that our present criterion for removal of the prostate by this or any other method should be residual urine. Just because a prostate is enlarged does not necessarily mean it should be removed. Many a patient suffering from adenomatous hypertrophy of the prostate has been carried along for years by palliative treatment, without operative intervention. It has been so in the past; it will be so in the future.

The greatest tribute is due Dr. Davis personally for the persistence he has shown against



great vitriolic criticism on several occasions, and for putting this method over in spite of it. When he can show only 3 deaths in 339 cases, his method merits one's favorable consideration.

DR. THOMAS C. STELLWAGEN: (Philadelphia) With frankness I confess that I came over from Philadelphia somewhat in doubt, but I am equally honest in saying that conversion to transurethral removal of the obstructing portion of the prostate gland, in selected cases, offers an apparent solution to a very hazardous operation. It is entirely probable that the operation of prostatic resection per urethra will have to pass through a formative stage. In my opinion the work of Dr. Davis and Dr. McCarthy has done much to shorten this formative stage. Most men after 50 are concerned about their prostates, and some of them undoubtedly would be greatly relieved by the procedures that Drs. Davis and McCarthy so ably demonstrated.

There is no question that prostatectomy is passing through the stage of understanding and development that appendectomy travelled during its introduction to the profession and the public at large. Many of us can remember the acrimonious disputes that were engendered between the two schools of belief in regard to the question as to when the appendix should be removed. This has largely, at the present time, been evaluated. When the patient has appendicitis, the appendix is taken out. Of course there are exceptions, but the old disagreements are a matter of the past. Education of both the general practitioner and the public is rapidly changing the present day status of the prostatic case. The urologist still has to contend with procrastination on the part of both the physician and the patient; but we all look forward to the day when the prostatic will be referred to the specialist before he has become seriously crippled by his disease.

The work that Dr. Davis has done, and the perfection of the procedure by Dr. McCarthy and Mr. Wappler, to my mind, will succeed in removing much of the sting of danger from early prostatectomy. To me the question resolves itself into the problem as to the type of case which is approachable by means of intraurethral resection. Malignancies and obstructions of the prostate that are not too large will be far better handled by this method than by any other surgical procedure. The frail old man who could not stand a suprapubic

or perineal prostatectomy can often be given relief for the remainder of his life by this method.

The question has arisen concerning the danger of hemorrhage. Of course it is a vital problem, but I cannot see that it is of such magnitude, even though it does occur; which fortunately does not often happen. It does not seem to me so much of a risk; for after all, it does not entail very serious shock to open the bladder subsequent to intraurethral resection and control the hemorrhage. This problem of hemorrhage control is largely eliminated by the coagulation powers of the current. Dr. McCarthy is at present working upon a device that I feel will give him the whip-hand over postoperative bleeding.

Another question that some critics have put forth is the necessity for re-resection in some cases. This again I do not see is of any great moment, since from what I have learned it will not entail any very great danger to life, and is a much less serious problem than removal of the gland by the old method.

DR. WILLIAM M. SPITZER (Denver): While I have not had a great deal of experience in this new field, I have resected a few cases. Most of them have been bars, the broad bar described by Dr. Randall which is a matter of inflammation, as well as the narrow bar. In those cases I have met success; but where I have attempted to go further afield and attack a large prostate, I have gotten into trouble and had to open up suprapubically, in 2 cases, for hemorrhage. This was probably due to lack of proper technique, or to lack of the proper current. Considering my experience with the current I have had to use (which was not the Liebel-Flarsheim or the Wappler machine), I think we may go into this field cautiously and carefully using this newer equipment, with much hope. The skill which has been so strongly emphasized is not so much a prerequisite as a thorough knowledge of the bladder neck, its physiology and anatomy, and the ability to interpret what we see. A certain amount of technique is, of course, necessary. But I presume we all have that. Time alone will tell whether this will be the method of choice in dealing with adenoma of the prostate.

In the larger prostates it is hard to say whether we are dealing with a true tumor or an inflammatory condition. If inflammatory, as mentioned before tonight, drainage of the

bladder itself helps to cure it. Therefore perhaps drainage of the bladder per urethra may not suffice.

None of us fears hemorrhage with an open bladder. But once gross hematuria caused by removal of an obstruction at the bladder neck, transurethral, sets in, a vicious circle is started. First comes the desire to urinate, and with that a whole chain of symptoms. More bleeding is caused by the efforts of the patient to empty his bladder. The attempt to empty causes more bleeding; and unless we can pump out the clots, and stop the bleeding by going in again, we are in deep trouble. Along this same line, I believe we have another problem. We are all moving away from catheter drainage, moving on to drainage of the bladder from above, because catheter drainage does not offer immunity against infection; but opening up from above does obviate such infection, the most frequent cause of death. This furnishes food for thought.

In short, this whole problem is all in the future. Many men will work on it. And the consummation of an ideal method will be arrived at only by our joint experiences and our combined failures and successes.

DR. A. HYMAN: I have been interested in this subject for a number of years; in fact, since Dr. Beer introduced the fulguration treatment of bladder tumors. In 1914 we reported a few cases at the Academy of Medicine, in which we had destroyed median lobes by a fulguration method similar to that described by Dr. McCarthy, with fair results. Later on our results were less uniform; and because of the poor endotherm apparatus at our disposal at that time, we became discouraged and dropped the procedure for a while.

A few years ago I had an opportunity to see Dr. Luys of Paris do his forage of the prostate. He demonstrated a number of patients with prostatic hypertrophy who had been *foraged* with excellent results. I was not, however, impressed by his method. It was crude, cumbersome, slow and painful. But I had an open mind on the subject, and felt that there was a future in this method provided the proper endotherm apparatus was devised. Therefore when Dr. Davis reported his wonderful results with the modified Stern resectoscope, and Dr. McCarthy followed with his new apparatus, it seemed the time had arrived for further trials of the procedure.

I accordingly spent a few afternoons with Dr. McCarthy at the Post-Graduate Hospital, and was greatly impressed by his technique and his results. Although my experience is not nearly as extensive as that of either Dr. Davis or Dr. McCarthy, I would like to tell you my impressions.

To date we have used this method on about 15 cases of prostatic obstruction of all types, including median bars and median and lateral lobe enlargements. At first I hesitated to resect the larger glands, confining the method to median lobe enlargements with very gratifying results. We then selected cases with lateral lobe enlargements. I must say that I am greatly impressed with the results so far obtained. There have been complications in 4 instances; a secondary hemorrhage which was readily controlled by coagulating the bleeding points through the cystoscope, a rather acute pyelonephritis lasting a few weeks, and epididymitis in 2 instances. To avoid the latter complication it will probably be advisable to do a preliminary vas ligation.

It seems to me that this new method has an excellent future, although I question whether it will entirely supplant prostatectomy. It will be a matter of a few years before its status can be definitely determined. Undoubtedly as the method becomes more and more popular and in more general use, unpleasant complications will be reported; which, however, should not discourage its use. Despite the opinion expressed by a few this evening, it is a highly technical procedure requiring cystoscopic experience, and is not to be entrusted to the tyro. The potential dangers seem to be perforation of the trigonal region, secondary hemorrhages, and cutting too far forwards, i.e., anterior to the colliculus, with resulting incontinence.

The important point in the whole procedure is the correct interpretation of the obstructive lesion, and to know just how much prostate to resect; and this is not as simple as it sounds. Some patients with enlargements of both median and lateral lobes have been relieved of their symptoms by resecting only the median lobe; others have not, and have required resection of the lateral lobes. At present, it is not often possible to decide just what part of the prostate is responsible for the obstructing factor. As a result of further work with transurethral resection, we may in time determine this point. I am convinced, after seeing the

motion pictures this evening, that I have not removed enough tissue, evidently being too conservative. As a result I have had failures in 3 or 4 instances. In one case we congratulated ourselves on an excellent result. Two weeks later retention developed. In 2 other cases, there was recurrence of residual urine. I think the most important question, after the necessary experience is obtained, is to determine just how much prostate it is necessary to resect, to obtain a satisfactory result.

DR. W. J. ENGEL (Cleveland): I have visited Dr. Davis' clinic at Charlotte, and know that he does the work he claims, and does it well. My own experience with transurethral prostatic resection covers a period of about two and one-half years. We started out with the Caulk cautery punch. Our results were very satisfactory with it, and it kept us interested in the work. From this we progressed to the resectoscope as modified by Dr. Davis. I am sure that if we had the mechanical and electrical genius of Dr. Davis, we would have been able to iron out the difficulties we encountered with this instrument. As it was, we pushed on to the McCarthy instrument, and found it superior in our hands. With these three instruments we have treated about 80 cases, and the results have been uniformly good. Fifty per cent of the patients had complete retention, the rest had large quantities of residual urine. In almost every instance they were restored to urinary comfort, with a minimum residuum.

It has been our feeling that the middle lobe is the chief factor causing obstruction. In many cases resecting the middle lobe alone restored urinary comfort, with freedom from residual urine. Subsequent cystoscopy after six or eight months has shown lateral lobe enlargement was still present, even though the patient was able to void comfortably and carried no residual urine. Whether or not lateral lobes constitute a minimum factor in obstruction, only time will tell. It seems to us to be the case.

This new procedure seems ideal in carcinoma of the prostate. We first resect the obstructing portion, giving the patient a good channel to void through, then give him deep x-ray therapy. The immediate results have been very gratifying, though of course a longer period of observation will be necessary. The longest case we have treated in this way has

gone one and one-half years in comfort. There will doubtless be recurrences, and we will again have to remove more tissue from the bladder neck to permit them to void. We feel that this is much better than the radical operation.

With this method the average hospital stay has been eight days in our group of cases. Convalescence is very comfortable and post-operative reaction slight. In short, we have quite a different picture following prostatic resection from that after prostatectomy. In most instances they are able to void immediately after removal of the catheter, in thirty-six to forty-eight hours. We have encountered some cases in which the final result has been delayed from two to four weeks, after which the patients void comfortably.

Our experience is not unique. In a communication from Dr. Alcock of Iowa City, I find he has treated to this date 96 cases, and is very enthusiastic. We are doing fewer prostatectomies, though there is still a group of cases where this is the procedure of choice. Each case must be individualized. Dr. Lower shares my enthusiasm for this new method and we feel it gives the same relief with a minimum of danger.

DR. J. J. VALENTINE: The Department of Hospitals of New York City has been most cooperative with our Urological Service at the Morrisania City Hospital. We have only recently been equipped with a McCarthy surgical unit and our experience with endoscopic prostatic revision is therefore limited to a few cases.

You have been given the history of the scientific advance made in bladder neck work. Personally, I have used all forms of endovesical resection, and like Dr. Hyman recall the work done years ago by Luys with his "forage de la prostate."

Perhaps because of having been one of the earliest enthusiasts of the McCarthy panendoscope, manipulations through it seem logical and practical. My experience with the original Stern resectoscope was very limited, and failures with it when it was first presented naturally should be attributed to our not having had the proper cutting and coagulating current at our disposal.

We have used the McCarthy surgical unit with his special panendoscope in 14 cases to date, classified as follows:

	Number of Cases
Middle and lateral lobes, benign hypertrophies	5
Carcinoma of prostate	2
Contractures of vesical neck following prostatectomy, i.e., scar formation, bands, persistent suprapubic sinuses, etc	3
Fibrous prostate	1
Median bar obstruction	1
Sclerosis of vesical neck (with existing diverticula) . .	2

Our results thus far have been very satisfactory. The technique should be relatively simple in competent hands. The McCarthy surgical unit certainly cuts easily and coagulates efficiently.

In one case, excessive bleeding occurred and was not controlled at the time of resection. This happened while making a test with a machine that was presumed to cut and coagulate efficiently. It was my desire to give it a fair trial. This machine cut out small pieces of prostate, but they appeared charred, and for some reason coagulation did not check the bleeding. Indwelling catheter likewise failed to arrest bleeding by pressure, and a cystotomy was performed a few hours later. The bleeding was arrested and in due time we intentionally allowed the suprapubic wound to close. The patient still had obstruction, and he was again resected, this time with the McCarthy unit. Several large bits of prostate were removed, and no bleeding followed.

Residual urine has been materially reduced in all of our cases. Some have had no residual since the local reaction from the operation subsided; others have a varying amount from a few cubic centimeters to  $\frac{1}{2}$  ounce.

The symptoms of discomfort and burning on urination after the catheter is removed seem to be temporary. We have noted these symptoms to last from seven to ten days.

We have had one death, a negro about sixty-eight years old, with a very large prostate and complete retention. Despite slowly decompressing him for about three weeks and favorable blood chemistry and renal function reported, his general appearance was poor, and ten days after resection he became uremic and died. Autopsy revealed bilateral acute and chronic diffuse suppurative nephritis. Perhaps it was an error to have resected in this patient, although with the findings at autopsy, there is doubt that he would have tolerated any surgical procedure.

It is too early for us to come to definite conclusions about this new method. There is no

question as to its efficiency, whether done by the Davis or McCarthy method. The reason the McCarthy method appeals to me more is that I feel thoroughly at home with the panendoscope. In this instrument, the lumen is so much larger and broader and permits looking directly ahead, that it offers perhaps an opportunity to remove larger pieces than through the Davis instrument. The matter of time with the McCarthy technique is negligible; for after the patient has received a caudal or spinal injection, the excision and coagulation takes but a few moments in the average case.

I would like to join Dr. Stellwagen and others who have cautioned those who make light of the technique of this procedure. I do not think it is quite as simple as it may seem; but it will be, in the hands of those who have delicate tactile sense and have had sufficient practice to learn the landmarks thoroughly.

DR. W. CALHOUN STIRLING (Washington, D. C.): I think the bugbear of hemorrhage and recurrence of the obstruction has been overemphasized by the critics of this new method. As Dr. Davis pointed out in his paper this evening, it is a simple matter to go in a second time if necessary, a few months or even years later, and resect any remaining obstruction with no added risk to the patient.

Considering the large number of cases reported by Doctors Davis, McCarthy, Caulk and others, I hesitate to report my modest series of 25, all done by the McCarthy technique. Most of these cases were in men with large lateral lobes, 5 of whom had acute retention. In all cases we were able to make a gutter through the obstruction and restore micturition. Recovery was complete in all cases, with very little hemorrhage except in the first few cases.

I was much impressed with Dr. McCarthy's technique today, and the excellent work he does. With the new machine made by Wappler the fulgurating current affords good control of hemorrhage. In fact, it seems to me that as time goes on we will do fewer and fewer prostatectomies, and more resections, with its lessened morbidity and lowered mortality in expert hands.

DR. T. M. DAVIS (*Concluding*): I do not think there need be any argument as to which instrument is superior to the others for this procedure. I am sure that our instruments are not at present the ideal of perfection. I agree that in the McCarthy instrument the vision is broader

than in the Stern resectoscope, the light in front of the lens, and you also have some right-angled vision. Personally, I am more acquainted with the direct vision telescope, and can orient with it better. The McCarthy resector is a nice instrument. I think it has a few defects, as I know the Stern resectoscope has; and they are faults which I have not been able to overcome.

I feel that the future of prostatic surgery lies in the prevention of hypertrophied prostates rather than in waiting until the patient has one foot in the grave and the other on a banana peel before attempting to do anything for him. It should not be a matter of locking the stable door after the horse is stolen. It is up to the urologist to educate the medical man to recognize these conditions early. In the median bars and the small hypertrophic glands, this process is not much more severe on the patient than a complete cystoscopic examination, and causes but little discomfort in the larger hypertrophies.

I agree with Dr. McCarthy that excessive coagulation is not necessary. I do not use the spark gap coagulating current longer than a fraction of a second to a vessel, except where we cannot find that vessel and we traverse the area rapidly with the current imposed on the loop.

As far as secondary hemorrhage is concerned, I have no fear of it whatever. The 2 cases I have had to handle required only five minutes after the patient received the caudal anesthesia until the bladder had been cleaned of clots and the vessel was coagulated. I was glad to have these 2 cases, to show how easy it was.

I think this change in procedure will accomplish one thing not controlled in the past. The operator on prostatic cases has often been the general surgeon. With this resection method that the urologist can offer, general surgeons will lose their prostatic cases, and the urologist will get first choice on deciding what shall be done. He will determine whether or not resection is indicated. In short, the prostatic cases will be returned to the specialist.

I do not see the comparison between tonsillectomy and prostatic resection. I do not think anyone ever dies from dysphagia following tonsillectomy. We do not remove adenomatous prostates for infection, but only for obstruction. Large adenomas should have prostatectomy; I

mean the tremendous glands where it is difficult to do any form of instrumentation with any degree of certainty as to what you are doing. But I believe these are the only cases which really have an adenoma. No other gland of the body develops adenoma with anything like the frequency credited to the prostate. I believe about 10 per cent of them are adenomas, and possible 12 to 15 per cent carcinomas. The hypertrophic glands will shrink after operation, and often remain permanently cured.

Someone has said that the only indication for prostatectomy is residual urine. In this I do not agree. I see cases of hypertrophy where there is bladder intrusion yet they can frequently empty their bladder through the prostatic obstruction. In other words, they have only an obstruction, a very few having small diverticula. I think that instead of waiting until obstruction produces residual, the thing to do is to remove the obstruction and stop the getting up at night to void, and so give the patient relief. One case I saw recently has no residual urine, yet he voids every fifteen minutes. He had a prostate so large that we could not do a resection. That is a case for prostatectomy.

We should be just as careful in preparing the patient for this procedure as for any other. In some cases suprapubic cystotomy may be necessary later. If we have to reoperate with a high non-protein nitrogen the patient is a poor operative risk.

As to the time element: this is governed by the amount of obstruction and the amount of tissue to be removed. Four or five years ago we spent three hours whittling away at these larger prostate glands. Now a median bar operation can be done in ten minutes. I have removed a large bilateral adenoma, removing 30 or 40 gm. of tissue, in one and one half hours. Where we find large arteries, of course, it takes longer. The sections of tissue taken out by my procedure with a No. 26 F. sheath are approximately the same in size as those removed by Dr. McCarthy with his loop and a No. 28 F. sheath. In fact, I believe that a larger section is removed with the instruments I use and a No. 28 F. sheath than with the McCarthy resector. In the lateral lobe cases it is possible to remove larger sections because they do not give way from you, and the instrument can get a better bite into the gland.

# ELLIOTT TREATMENT OF PELVIC INFLAMMATIONS\*

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THE treatment of pelvic inflammations is often prolonged and inefficient. Heat has been used for centuries, but never in so satisfactory a way as that devised by Dr. Charles Robert Elliott.

A thin, distensible, gum rubber bag is inserted in the vagina. Through this a constant circulation of hot water is maintained by an electric pressure pump on one side and a suction pump on the other. The temperature of the water in the machine is regulated by a thermostat and should not exceed 130°F. at the conclusion of the usual one hour treatment.

Holden<sup>1</sup> has shown that this will produce a temperature of 106°F. in the peritoneal cavity and rectum, and 104°F. in the bladder.

A pressure of from one to 4 lbs. is produced in the bag by the use of regulating valves on the inlet and outlet tubes. This distends the vagina, obliterating its rugae, and greatly increases the area available for heat radiation. A treatment is usually given daily. The number may vary from five to twenty. A fair average would be ten treatments.

What are the physiological effects of these treatments?

1. The production of a marked hyperemia in the pelvis.
2. An average increase of 17 per cent in the leucocyte count of 87 per cent of the patients treated.<sup>1</sup>
3. A local elevation of temperature in the vagina, uterus, rectum, bladder and pelvic peritoneal cavity of from 5° to 7°F.
4. The production of a profuse discharge from the cervix and vagina.

<sup>1</sup> Holden, F. C., and Gurnee, W. S. A new method of applying vaginal heat. *Am. J. Obst. & Gynec.*, 22: 87, July, 1931.

When these physiological changes are produced in inflammations of the pelvis, they cause:

1. A prompt subsidence of congestion and inflammation.
2. A resorption of exudate.
3. A definite destruction of bacteria.
4. An out-pouring of mucus and washing away of infective organisms from the cervix and vagina.

There are undoubtedly other effects that are less clearly defined and understood. From a clinical standpoint, we can say that inflammatory masses melt away; pain and tenderness disappear and a foul, purulent discharge from an angry red cervix and vagina is replaced by clear mucus coming from a normal cervix or one showing translucent clear cysts deep in its structure.

Best of all is the fact that a process that formerly consumed weeks of time may now be consummated in as many days and a much higher percentage of the patients treated show a splendid final result.

In 150 consecutive cases of acute salpingitis, chronic salpingitis, pelvic cellulitis and pelvic abscess, Holden<sup>1</sup> lists 81 per cent at the conclusion of treatment under the classifications of: "No pathology, marked improvement, or considerable improvement."

Another startling fact seems to be the marked decrease in the number of operations necessary in these cases. Miss Mackin, the technician at the Jersey City Hospital, states that in her series of 125 patients receiving Elliott treatments, only 8 were operated upon.

The average number of days spent in the hospital is diminished, also, with a

\* Read before the Alumni Association of the Ex-Internes of the Methodist Hospital, Brooklyn, N. Y., February 25, 1932.

consequent reduction in expense to the patient.

If patients and physicians can be educated to early treatment of pelvic inflammations, the period of hospitalization will, doubtless, be still further lessened and complete restoration to normal more often obtained.

In what types of disease is this treatment indicated?

1. Acute salpingitis.
2. Chronic salpingitis.
3. Pelvic cellulitis (frozen pelvis).
4. Post-partum and post-abortum parametritis.
5. Pelvic abscess (before and after operation). When used preparatory to operation, an amazing resolution will often take place and the operation may be unnecessary. After cul-de-sac drainage resorption of the exudate rapidly takes place.
6. Pelvic peritonitis.
7. Gonorrheal vaginitis or endocervicitis. The gonococcus is very sensitive to heat and is easily killed. Gonorrhea seems to yield promptly to the Elliott treatment.
8. Dysmenorrhea. "Daily treatments for five days preceding menstruation for three or four months" (Holden). The mode of action is unknown. It has worked in a few cases.
9. Cystitis. Tenesmus and pain rapidly subside.
10. Proctitis. Same as cystitis.

There seem to be no definite contraindications, but certain precautions are necessary. The bladder and rectum should be empty before treatment is commenced.

The first treatment should be limited to one-half hour, and the distention and the temperature should remain low to inspire confidence in the patient. Succeeding treatments take one hour. The temperature starts at  $115^{\circ}$  and is slowly raised. It should not exceed  $130^{\circ}$ .

The bag should be well distended but the treatment should be painless. The amount of pressure may be determined the first time by inserting the finger into the vagina alongside the bag. At subsequent treat-

ments, the same pressure, as indicated on the meter, can be used.

The inlet and outlet tubes from the bag should not be allowed to drag on the perineum. This is most sensitive and easily burned. A rolled-up blanket under the flexed knees will hold the tubes up nicely. The tubes should also be surrounded by a piece of gauze to prevent contact with the sides of the introitus.

After each treatment a speculum is gently inserted; the secretion is wiped away from the vagina and the cervix, vault and walls of the vagina inspected. If there is any tendency for a slough to form, the treatments are continued, but the temperature and pressure are lowered. All treatments are discontinued during menstruation.

Our interest and enthusiasm for this method of treatment were stimulated by the first case in which we used it:

E. C., a woman twenty-seven years old, was sent into the First Surgical Service of the Methodist Hospital by Dr. G. H. Davis. She had one child three years old and had been suffering from menorrhagia and a foul-smelling yellow leucorrhea, for two years. She had a progressively increasing constipation and pain in the lower abdomen on defecation. Vaginal examination showed a transverse mass in the cul-de-sac about 2 by 3 inches in size and stony hard, like a carcinoma. A proctoscopic examination showed an extra-rectal mass about 4 inches from the anus which projected into the rectum so much that the tube could not be passed around the projection. The rectal mucosa was normal.

The patient was thin and emaciated and gave a history of a previous tuberculosis of the lungs. A tuberculous tube was considered.

An Elliott treatment of one hour's duration with a temperature of  $128^{\circ}$ – $130^{\circ}$  was given. This was followed by a profuse flow of blood from the uterus. Treatments were discontinued for a week. An examination then showed that the mass was only half its original size. Three more treatments were then given, with complete disappearance of the mass. When seen February 12, 1932, the patient had gained 13 lbs. in weight and was in good health. There was no mass in the pelvis. A slight thickening of the uterosacral ligaments could be felt.

The interest created by this first case inspired us to visit Dr. Cosgrove at the Margaret Hague Memorial Hospital in Jersey City. He told us of 20 cases of post-partum infection that had been treated by the Elliott method, with good results. Two cases of cystitis received relief, and one patient with *Trichomonas vaginalis* vaginitis obtained almost immediate relief. A block away we found an Elliott treatment room in the Jersey City Hospital; Dr. Kelly is supervising this. Some are hospital patients, but many of the patients there are receiving ambulatory treatment. The results are not so promptly obtained in this way, but seem to be very satisfactory in properly selected cases. Better appetite; better sleep and gain in weight accompany lessened pelvic pathology.

I wish there was space in this paper to include the detailed report of these cases kindly sent to me by Miss Mackin. They include acute salpingitis, pelvic abscess, chronic pelvic inflammations, post-abortal parametritis, post-partum parametritis and cystitis.

Two very interesting cases are cited where patients with bilateral salpingitis with palpable masses have become pregnant after receiving ten and twelve treatments respectively.

We next visited Bellevue Hospital and spent a very interesting morning with Doctor Holden. After more than two years of experience with a large number of individuals, we found him still enthusiastic. Two patients were receiving treatment as we visited the room. One had an acute gonorrheal vaginitis.

A letter to Dr. George Gellhorn, President of the American Gynecological Association, brought the following response:

I am glad to say that I have used the Elliott machine for the past year and am very much pleased with the results. Although I have a good many patients who receive the treatment at the office, I believe that its greatest value would be found in hospital work, where patients can be kept at rest.

Let me cite a few of the cases that have been treated at the Methodist Hospital by a number of different men.

F. C., aged thirty-one years. Dr. G. H. Davis.

*Complaint:* Pain in the right side, dysmenorrhea, and dyspareunia. Had a resection of the right tube and ovary in May, 1922. Entered the Methodist Hospital on January 27, 1932. Vaginal examination showed a fixed retroversion and an inflammatory mass the size of an egg in the right vaginal fornix.

She was given eight Elliott treatments. The mass entirely disappeared and the uterus could be brought forward into normal position, but dropped back again, when unsupported.

An operation for the retroversion at a later date has been advised.

M. C., aged forty-three. Service of Dr. Seymour Clark. Was in the Methodist Hospital from January 24, 1931 to February 14, 1931, suffering from a pelvic abscess. A posterior colpotomy was performed. She remained in bed at home for six weeks after leaving the hospital.

In September, 1931, she began to experience menstrual irregularity and, late in November, had a marked flow followed by a foul vaginal discharge with indefinite pain in the lower abdomen.

Vaginal examination showed a hard, tender mass the size of a lemon situated in the cul-de-sac. There was no fluctuation.

Four Elliott treatments were given. Nine days after admission there was a purulent discharge from the vagina. Seven more treatments were given and she was discharged from the hospital, twenty-two days after admission. The sedimentation time changed from thirteen minutes to four hours during this interval. An examination made by Dr. Clark about a month after discharge from the hospital showed a pelvis free from pathology.

H. O., aged twenty-three. Had suffered pain in the lower left quadrant for one month and a purulent vaginal discharge for four or five years. Admitted to First Surgical Service of the Methodist Hospital January 14, 1932.

Vaginal examination showed a pelvis filled with a hard immovable mass (frozen pelvis). Under nineteen Elliott treatments, the uterus became freely movable and the entire mass disappeared with the exception of a small rounded non-sensitive left tube. The patient insisted on leaving the hospital as she was free



from pain, had no vaginal discharge and felt perfectly well.

O. C., aged twenty years, admitted January 7, 1932 to the First Surgical Service of the Methodist Hospital. Had suffered from a purulent vaginal discharge with pain in the lower abdomen for three years, following a miscarriage.

Vaginal examination showed marked tenderness in the fornices, a badly eroded cervix and an angry red vagina, with profuse, foul, dirty vaginal discharge.

Eleven Elliott treatments were given. The pus entirely disappeared and was replaced by a clear mucus visible in the cervix. The pelvic pain and tenderness cleared up and the erosion of the cervix diminished rapidly in area. Electric cauterization of the cervix was performed to clear up the cystic condition.

M. G., aged twenty years, admitted to the First Surgical Service on November 23, 1931, with a retroversion and acute pelvic inflammatory disease.

One Elliott treatment was given. The operator was inexperienced and maintained the pressure at 4 lbs. for one hour in spite of the patient's complaint of pain. A slough about one inch in diameter occurred in the vault of the vagina. This was well healed in ten days.

A. J., aged twenty-seven years, was admitted to the First Surgical Service of the Methodist Hospital on December 1, 1931, with a Bartholin's abscess and acute gonorrhea.

She was three months pregnant. The Bartholin's abscess was opened. Cervical smears showed the gonococcus.

Twelve Elliott treatments were given. All discharge ceased and the cervical smears re-

mained negative even after a provocative silver nitrate application.

There was no interference with the pregnancy. Discharged recovered on January 7, 1932.

The question may be raised: Have you not chosen your best cases to present?

In reply, I may say that our records show almost uniform improvement in every case of pelvic inflammatory disease that has been thus treated.

This treatment is not entirely confined to the female, for a prostatic bag for insertion in the rectum offers great possibilities in cystitis and prostatitis and even peritonitis in the male. The pressure in this bag should not exceed 2 pounds.

In conclusion, let me again quote the remarks of Dr. George Gellhorn.<sup>1</sup>

This . . . will help to cure a large number of pelvic inflammations, painlessly, without mutilation, without danger, in a short time, at a very moderate expense, . . . without the protracted convalescence or the aftermath that will follow so many cases that have been operated on for inflammatory conditions.

I wish to express my indebtedness to Dr. Holden of Bellevue, Dr. Cosgrove of the Margaret Hague Memorial Hospital, Dr. Kelly and Miss Mackin of the Jersey City Hospital, and the other members of the Staff of the Methodist Hospital for their courtesy and aid in this study.

<sup>1</sup> Gellhorn, G. *Bull. St. Louis M. Soc.*, June 5, 1931.



# HYDRAULIC VICIOUS CIRCLE AS IT DEVELOPS IN ACUTE APPENDICITIS\*

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EVIDENCE is accumulating that many bacteria normally pass into the blood stream without producing infection. The alimentary canal seems to offer a fairly free port of entry. Hydraulic vicious circle offers an explanation of the mechanical factors which allow bacteria to gain the ascendant over the resisting forces of the body, and produce infection.

This study centers largely about the functions of the capillaries, so beautifully expounded by Krogh. As long as the capillaries are freely open and deliver a normal supply of oxygen and nutrition, the tissues are able to maintain their mastery over the invading germs; but allow pressure to close the capillaries and deprive the tissues of oxygen, and the bacteria which are anaerobic or facultatively so will overcome the asphyxiated tissues and blood cells, and infection will take place.

This is the essence of this thesis, and the heart of the problem of the mechanics of infection, at least in the case of pus-producing organisms.

Following injury (destruction of capillaries) the presence of foreign bodies (including bacteria) or blood clots produces stasis of the blood stream. Local deoxygenation results. If no bacteria are present or only a few, especially when of mild virulence, the normal flow of fluid from a higher to a lower pressure will soon develop a stream away from the point of stasis, new capillaries and veins will develop, and normal conditions will be restored without allowing infection to take place.

When, however, the bacteria are sufficiently numerous and virulent to inflict casualties with debris, to further interfere with a free capillary circulation, a pocket

will develop which will collect the exuding fluid and debris. Increasing hydraulic pressure in this pocket will further arrest the capillary flow and will establish the hydraulic vicious circle. The retarded blood stream, the resulting deoxygenation, and the histamine-like substances (toxins) will all add to the permeability of the capillary wall which hastens the effusion and completes the vicious circle: more pressure, more effusion, more pressure, more effusion.

Arterial pressure carries fluid in; venous and capillary stasis prevents its outflow; the filling pocket increases the stasis, which means more effusion and more pressure, until comparative equilibrium is reached. Just where is this equilibrium; that is, at what point of pressure in the pocket will further effusion cease? This is an interesting query which has not been fully answered. Of course, it will vary tremendously in the innumerable conditions to be found.

In experimental intestinal loops and in obstructions in the urinary tract, it has been variously measured as from 30 to 60 cm. of water. This is clearly sufficient to arrest the stream in the capillaries, which physiologists tell us normally runs from 0 to 10 cm. of water.

Who will contrive a device with which to calculate the pressure in abscess, appendicitis, gall bladder, etc.?

There are many other factors involved: Immunity, relative virulence, chemical, nutritional, osmotic, etc. This is an effort to cover only these mechanical factors.

The mechanics of hydraulic vicious circle are illustrated in Figure 1, an imitation appendix. The circulation is imitated by placing a very thin walled rubber tube between two toy balloons, one slipped over

\* Submitted for publication October 19, 1931.

the other. At 10 cm. pressure (scale No. 1) blood flows freely through the blood vessels as in the veins and capillaries of the normal

but no progress. The following conclusion was made at that time: The demonstration seems complete that distention of the gut

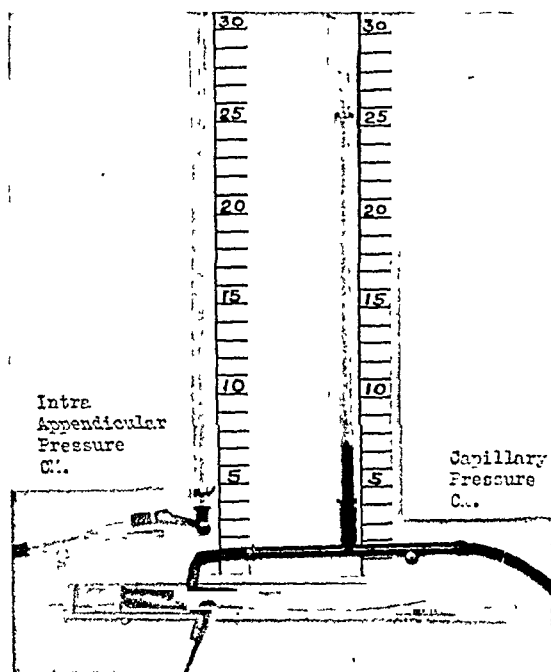


FIG. 1. Artificial appendix. Thin-walled rubber tube running to tip and back between two layers represents circulation in appendix. Pressure record on scale to right hydraulic pressure. In lumen of appendix on left. Normal capillary circulation (10 cm.) in healthy appendix shown by free flow from tube.

appendix. Obstruct the lumen of the appendix and allow the hydraulic pressure therein to rise to 20 cm. (scale No. 2) and blood ceases to flow. The *hydraulic pressure* in the *lumen* is *higher* than that in the *veins* and *capillaries*, and closes them as by a clamp.

In 1907<sup>1</sup> I made a number of observations on the blood flow in the bowel wall as affected by varying pressures by means of a light within the lumen of the small intestine. It was observed that with distention of the intestine by a pressure of 30 mm. of mercury some capillary streams were arrested; at 60 mm., small veins were arrested, and in most veins the current was slow; at 90 mm. all blood streams were moving slowly, and many but not all currents were changing direction frequently; at 130 mm. pressure, all circulation ceased, and there was some oscillation of corpuscles

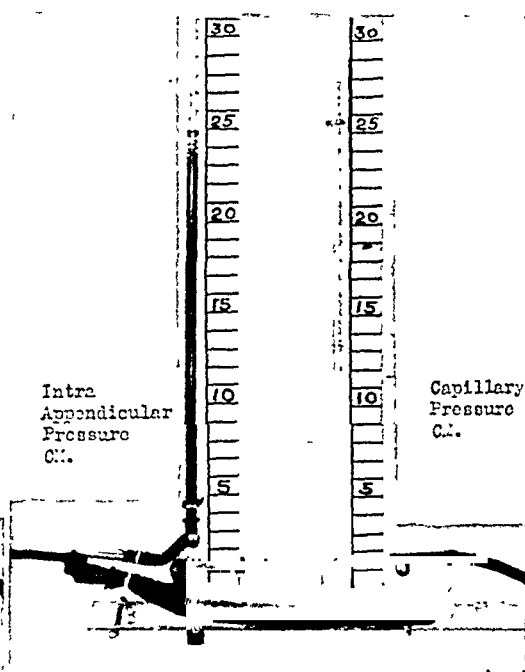


FIG. 2. Artificial appendicitis. Hydraulic vicious circle. Scale on right records hydraulic pressure in capillaries in cm. water. On left hydraulic pressure in lumen of appendix. Arrested circulation in capillaries of distended appendix (20 cm.) shown by absence of flow from tube (A). Distention means obstruction. Retarded blood supply means more effusion and more pressure.

(or of other hollow viscera) interferes with the circulation in its wall, and allows infiltration and effusion to take place into its walls and lumen and any other open spaces which may come within its influence. The return circulation is retarded at comparatively slight pressures. Effusion follows, as in all obstructions to venous flow. As the average venous pressure in the intestine under ordinary circumstances probably varies from 4 to 10 mm. of mercury, any pressure beyond that will offer some resistance to the return current. Drops of fluid accumulate upon the surface of the gut, like beads of perspiration. Effusion occurs outside as well as inside the intestine.

This accumulating of fluid and its strangulating effect upon the circulation in

the intestine have also been demonstrated with distended loops by Morton,<sup>2</sup> Burget,<sup>3</sup> Dragstedt,<sup>4</sup> Owings,<sup>5</sup> Stone,<sup>6</sup> Weinberg,<sup>5</sup> and others.

**Abscess.** Abscess begins with the planting of pathogenic bacteria in tissues otherwise healthy and is nearly always the result of a wound, often microscopic and not observable from the surface.

The first step is pictured by Krogh in a footnote:

In a microscopic field, containing in vitro, leucocytes and bacteria, a leucocyte, at a certain distance from the bacteria, becomes suddenly active and moves directly towards the bacteria, pushing the red cells in its way to right and to the left. Whatever the ultimate explanation of these chemotactic attractions may be, they are all important factors in the defense of the body.

The blocking of the blood vessels is immediately followed by edema at that point with resulting pressure on the veins and capillaries and the beginning of the hydraulic vicious circle: more pressure, more filtration of fluid, and more blockade of the blood vessels. Along with the effusion comes the escape of leucocytes. These leucocytes immediately begin the building of a wall of cells to stay the advance of the invading bacteria. This pyogenic wall forms a cavity in which the struggle between the body cells and bacteria goes on to the death of millions on both sides. These dead cells and bacteria plus the fluid (serum) which results from the hydraulic vicious circle constitute the pus of the developing abscess.

The fact that deoxygenation is present in this condition, follows inevitably from the retarded circulation (congestion), the prominent feature of hydraulic vicious circle.

Our sense of touch is sufficient to demonstrate that the pressure in a boil or in an inflamed appendix is much above the normal pressure in the capillaries and veins. In experimental production of obstructed loops of intestine, and in measuring the

tension in the chronically obstructed bladder, we have records of pressure up to 50 and 60 cm. of water (Burget,<sup>3</sup> Morton,<sup>2</sup> Dragstedt,<sup>4</sup> Owings, McIntosh, Stone and Weinberg<sup>5</sup>). These pressures are more than sufficient to arrest the normal circulation in the capillaries and veins.

Another evidence of the great tension which is present in these conditions is the relief of pain which follows the opening of an abscess, such as a subperiosteal abscess, a felon, a post-tonsillar abscess, or even the pulling of a tooth where the pressure accumulating in the abscessed root causes excruciating pain. The great tension often present is evident from the spurting of the pus which is observed upon the opening of these abscesses. Those who have seen the discharge of pus under these conditions know that tension far beyond that sufficient to stop the circulation in the capillaries and veins is present. It seems strange that medical literature is so full of references to great tension in abscess, in the appendix, in knuckles of the intestine, hernia, gall bladder, and glaucoma, and yet no one, so far as I have been able to learn, has attempted to measure these pressures, or to estimate them, except possibly in the case of glaucoma.

Once the hydraulic vicious circle is established the further progress of the abscess is very simple. The principal attention is still centered upon the circulation. The hydraulic pressure in the pocket slows the circulation progressively up to the point of complete arrest. A slowing circulation means congestion and deoxygenation. The bacteria revel in the absence of oxygen and produce infection of an intensity depending upon the virulence of the bacteria and the immunity of the tissues. Strangulation is now complete, and necrosis and gangrene follow as a natural consequence of the arrested circulation, the deoxygenation and bacterial toxins. If death of tissue affects small areas, we call it necrosis. If large areas, it is gangrene. This is the mechanics of necrosis and gangrene, and thus is the mechanical arrest

of the circulation explained. Hydraulic vicious circle is responsible.

*Deoxygenation.* Haldane<sup>3</sup> says: "You, reader, will die of oxygen want. Your lungs, your heart, or that part of your brain which controls the respiratory muscles, will cease to play its part in oxygen supply and the energy transformation which makes up your conduct will cease."

The result of sufficient anoxemia is death. Anoxemia is a large factor in the death of tissue in necrosis and gangrene. Congestion, lack of oxygen, is one of the first results of hydraulic vicious circle.

Simply deprive normal tissue of oxygen and it will die. But deoxygenation adds another death-dealing element. It assists bacteria, especially anaerobic, to grow. It sets the stage for infection.

So far as I have been able to learn this step in the incidence and progress of infection has never been studied or discussed in medical literature.

Congestion, asphyxiation, deoxygenation are obviously and constantly present in the tissues surrounding abscesses, in appendicitis, and in intestinal obstruction. For evidence of lack of oxygen in these conditions I asked Dr. N. E. Burget to make some oxygen determinations in the intestinal loops which he is studying in dogs. In a personal communication he says:

Preliminary work has indicated that the fluid from a loop distended and under considerable pressure contains very little oxygen. Fluids from non-distended loops contain a normal amount of oxygen, that is an amount similar to that of other body fluids. While we shall continue the investigation, the results indicate that the oxygen is used up by the anaerobic organisms when the circulation is blocked by distention of the loop.

The action of anaerobic bacteria is in addition to the natural dissipation of oxygen from the congested area. I know of no data on the rate of disappearance of oxygen from an arrested vein.

The effect of this lack of oxygen upon the development of bacteria in this and other pockets is evident. Weinberg and his

associates<sup>9</sup> found that practically one-half of the bacteria found in acute appendicitis are anaerobes, and it is generally accepted that the majority of pathogenic bacteria are *facultative* anaerobes. This is especially true of pus bacteria.

*Acute Appendicitis.* Acute appendicitis presents a perfect picture of hydraulic vicious circle, and it is natural that I should have found it first in this condition. Acute appendicitis is due to narrowing of the lumen of the appendix at some point in its length. The cause of this constriction may be a congenital malformation, a peritoneal band, a Jackson's membrane, an inflammatory scar formation, or any irregularity. The appendix is prone to irregularities in shape. A perfectly smooth, well-formed appendix will never suffer appendicitis. It is a common observation that as the appendix grows older, being a vestigial organ, it has a tendency to become more and more contracted and filled up with connective tissue (sclerosis). Other causes of narrowing are recurring acute attacks of mild appendicitis and peritoneal disturbances which may increase peritoneal bands and by contraction twist the appendix or kink it more sharply as time goes on.

*Constrictions in the Appendix.* For twenty-five years, I have looked for constrictions of the lumen of the appendix in acute appendicitis, and never in all that time have I failed to find some narrowing, provided that I had opportunity to make a complete study of the specimen, beginning before the appendix was disturbed from its bed. Pulling it up with the fingers may disturb peritoneal bands or straighten out kinks so as to prevent the casual observer from discovering the obstruction. This is nicely illustrated by Wilkie,<sup>14</sup> who shows how the appendix can be bound down by bands, causing obstruction, and how releasing these bands in order to bring up the appendix will relieve the obstruction, and the pathologist will be unable to find it.

Often the constriction is very near the cecum and in removing the appendix it

is severed at the point of obstruction, or even slightly distal to it. In that case, when the appendix reaches the pathologist it shows no evidence of obstruction or constriction. It is obvious that we cannot depend upon the pathologist's report as to the findings of narrowing of the lumen of the appendix. Sometimes the constriction is so slight that a casual study will fail to observe it, and still it will be sufficient to hold a fecal plug long enough to produce congestion and infection.

When one operates late in the progress of appendicitis, the appendix is often so much destroyed by necrosis and gangrene that the constriction is not easily recognized. It is the task of the surgeon to locate it, and if he will make a careful study, he will never fail to find it in any case which is worthy of the diagnosis of acute appendicitis.

In the early studies of appendicitis, edema and infiltration of the mucous membrane were frequently observed, and the natural inference was drawn that obstruction was the result of this edema and swelling of the mucous membrane. This theory has been repeated in the literature about appendicitis, but has no foundation in fact. The obstruction was present in the appendix before the infection began, and was not due to edema or swelling of the mucous membrane. Edema is commonly present in appendicitis, but I have never seen it cause obstruction. For the purpose of record I am suggesting the following classification:

- A. Club shaped, congenital.
- B. Kink, mesentery.
- C. Peritoneal band.
- D. Stricture, inflammatory or degenerative.

*Obstructions in the Appendix.* Next to the constriction, the obstructing plug is worthy of careful study. Since everything in the colon is classed under the head of "fecal matter," the obstruction is always composed of fecal matter or its derivatives. The most common obstruction is a plug of ordinary compressed fecal matter. This

may be in the form of a firm mass, easily discovered, but often it is merely a mass of granular debris. I have removed dis-

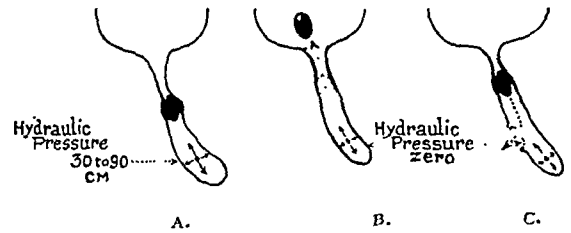


FIG. 3. Appendicitis.

- A. Obstruction is followed by distention, congestion, anoxemia, prompt infection.
- B. When rising hydraulic pressure drives obstruction into colon after one to ten hours, infection will be mild, "catarrhal."
- C. When obstruction holds circulation is arrested. Necrosis, gangrene, perforation, peritonitis follow.

tended appendices, very evidently obstructed and with a marked constriction, and upon opening the appendix have failed to find any definite obstructing mass. One may find only granular debris which immediately mingles with the pus, mucus, and feces, in the appendix. Both of these forms of obstruction, whether a plug of feces or a granular mass, are so easily overlooked that it is no surprise that the element of obstruction in the appendix has so long eluded study. The next and more obvious type of obstruction is the concretion. This concretion, developing as it does in the very mouth of the constriction in the appendix, will naturally be shaped to fit the constriction and will produce a perfect ball valve.

*Development of Concretion.* Fecal matter consists of a mass of remnants of food together with numerous bacteria. These masses pass into and out of the appendix freely. Being naturally of a sticky nature, one mass will adhere to another and after they have passed the constriction, will become fused in the cavity beyond. As more passes into the appendix, the lump will grow in size.

The peristaltic contractions of the appendix will drive out the fluid parts of this mass, leaving the more inorganic solid matter behind. All parts of this mass which

are digestible and soluble will be digested and dissolved by the bacteria and secretions and will pass out into the colon. During this process the mass becomes more and more indigestible, until only cellulose and salts, mostly calcium, remain. Held by a constriction, a small concretion will, in the course of years, grow by gradual accretion, until some shift of position fits it into the constriction firmly and blocks the lumen of the appendix. This process may continue for years, sometimes a lifetime, before anything further results than the formation of a concretion. For the purpose of record and study, I am suggesting these three types of obstructions:

1. Concretion.
2. Fecal mass.
3. Debris, including appendiceal contents in which no definite obstructing mass can be identified.

Physiologically the contents of the cecum have free access to the appendix, and, undoubtedly, more or less of the contents of the cecum are constantly passing into and out of the appendix. Numerous observations by many roentgenologists have established this fact.

With the constriction established and the obstruction formed, whether it is a fecal mass, a mass of debris, or a perfectly fitting concretion, the stage is all set for an attack of acute appendicitis. All that is now necessary to spring the trap is to have something fix the obstruction in the constriction. This may proceed very quietly by simple peristaltic contraction forcing the plug into place and holding it there long enough for the normal secretions of the appendix to press it home. In other cases the colon, with its contents in an uncommonly liquid condition, or in large amount, by a sudden contraction will force sufficient fluid into the appendix to push the plug into place with a snap, closing a perfect ball valve, and will immediately produce considerable hydraulic pressure in the appendix cavity. Undoubtedly many of the extremely acute attacks which come on suddenly with excruciating pain are of this type.

Whatever the cause of the closure of the ball valve, the first result is the accumulation of secretions behind it. All mucous membranes secrete more or less fluid and mucus, and in the beginning it is probably the normal secretions which begin the distention. As soon as a pressure equal to that normally present in the veins accumulates, there will be a slowing of the circulation and a beginning of the hydraulic vicious circle. This is in the neighborhood of 10 cm. of water pressure. Once this point is reached, the increase will be more rapid, as the fluid now leaves the blood vessels largely by filtration. *Hydraulic vicious circle is now established and will take the same course it does in abscess.* If the obstruction is compressible, or the constriction dilatable, or both, this pressure, when it reaches a point sufficient to force the obstruction past the constriction, will drive it back into the colon. If not, a virtual abscess results and goes on to necrosis, gangrene, rupture.

*The Obstruction Gives Way.* If there is but slight obstruction it may give way in a very few minutes. It may produce only a twinge of colic, in which peristalsis of the appendix plays an important part, and practically no other symptoms. There may be a mild infection which may add to the irregularities and constrictions of the appendix by scar formation. The obstruction may last so short a time that only a beginning hydraulic circle will be established. A longer period of obstruction will produce greater pathologic changes and, of course, if it does not give way within twenty-four or thirty-six hours, necrosis, gangrene, and rupture follow. All the various pathological conditions found in acute appendicitis, often to the extent of prompt gangrene of the entire appendix, may take place, depending upon the firmness of the obstruction and the virulence of the infecting bacteria, and the length of time the obstruction holds. If the obstruction gives way within a couple of hours, a mild infection will be the result.

Immediately after the tension is relieved there is free drainage, the circulation is restored, oxygen is again supplied in abundance, and in a few minutes the picture is entirely changed. This change is often very apparent to the patient as he sometimes suddenly feels the relief from pain and declares that he is feeling much better.

If an appendix is removed soon after this point in the attack, it will be found very much congested and the pathologist will say that it is infiltrated. It is acute appendicitis, and if the obstruction has held for only a short time (one hour), it will be of mild character, probably confined to the mucous membrane of the appendix. In other cases, where the obstruction has held for four or five hours, we find traces of necrosis, and in many hemorrhagic infarcts and often free hemorrhage into the appendix, evidence of the strangulation which had been present.

It is not my purpose to dwell upon the various types of pathology which follow this temporary obstruction of the appendix, with temporary establishment of hydraulic circle. Probably a majority of the appendices removed in the average clinic will fall somewhere in this class. There is first the frankly superficial infection of mucous membrane, often called catarrhal appendicitis. Obstruction for a little longer time will allow the infection to involve the submucosa, and from there on the inflammation will extend to varying depths into the wall of the appendix, depending upon the length of time the obstruction was present. More and more of the circulation will be involved, with more and more petechial infarcts, and often more or less free hemorrhage into the appendix. Superficial and deep inflammation, edema of the mucous membrane, sometimes filling the cavity of the appendix, superficial necrosis, in fact all of the conditions which follow acute strangulation with infection, depend upon the length of time that the appendix was obstructed. If the obstruction does not give way before mass necrosis occurs, rupture of the appendix will follow.

We know that with free drainage into the colon which follows escape of the plug the patient will recover from this attack very promptly; and even where no operation is done, such patients recover quickly. There will be a little rise in temperature from the mild infection, tenderness for two or three days, slight lassitude, and some digestive disturbances. But we have here the picture of an abscess which opened very early, before it had fairly begun, and in which free drainage is followed by prompt recovery. At the same time, removal of an appendix after an attack of this kind is advisable because the victim of such an attack is almost certain to have further attacks. Our study of obstruction has shown that these attacks are nearly always followed by an increase in the degree of constriction.

How can we demonstrate that such an obstruction has been present and that such a plug has been driven out? This is the constant challenge of the pathologist and of the clinician. To me, and to many others, the conclusion is obvious from the premises, especially when supported by the condition of a large number of appendices which we see removed during the stage of obstruction and distention. Mechanically it seems obvious that the plug will often be driven out. We know that hydraulic pressure rises behind it. We are constantly finding appendices distended with fluid, ready to burst. Rising pressure drives a bullet out of a gun; why should not pressure drive a fecal plug out of an appendix.

Outside of the blood vessels very few pressures in the body have been studied. Hence to determine the pressure necessary to empty the rectum, I provided a glass tube with scale attached to connect to the enema can and asked a couple of nurses to record the pressures developed by different patients in expelling their enemas. They reported an average range of 30 to 40 cm. Should it take more pressure to force the same sort of material from the appendix than from the rectum? Is it not logical that as these pressures are reached in the dis-



tended appendix the fecal plug will be driven out?

Professor Wilkie<sup>10</sup> tells of feeling a con-

We watched the stools, and, *I am sure, saw the concretion*. It never occurred to me to fit it in the appendix.

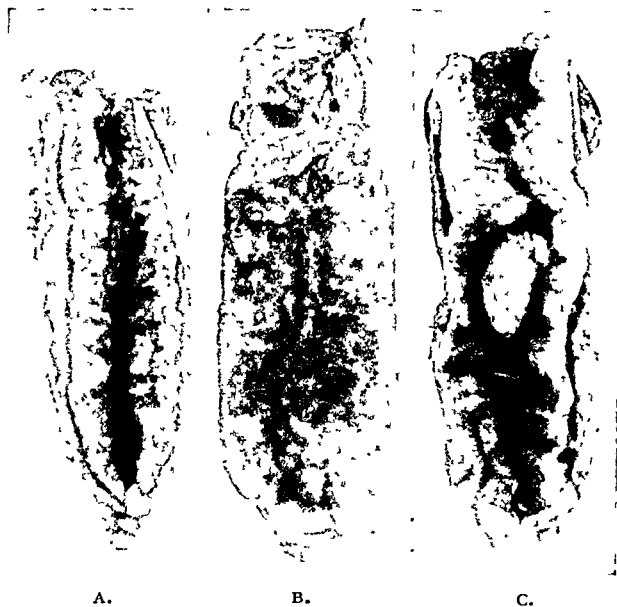


FIG. 4. Appendices, showing effects of distention.

A. Constriction at cecum lost in amputation; obstruction, six hours' acute catarrhal appendicitis; appendix congested, edematous; infected mucosa.

B. Appendix distended at operation eighteen hours after onset; proximal, one-half inch normal; acute appendicitis; sharp line of demarcation at constriction; strangulation; small hemorrhages and beginning necrosis.

C. Appendix distended at operation eighteen hours after operation; concretion at constriction; sharp line of demarcation at constriction between normal and strangulated tissue.

cretion in a distended appendix which, after manipulation he felt slipping into the cecum, where it was distinctly identified.

Dr. Addison H. Bissell of Stamford, Conn., in a private communication, reports the following interesting case:

One case was a pretty demonstration of your contention. I exposed a typical "red hot" appendix. As I put my fingers under it to lift it out, there was a decided "plop," and the appendix collapsed like a punctured tire. The material in the appendix could be seen to squirt into the cecum. Palpation showed a concretion in the cecum. There was active peristalsis in the appendix, and it wiggled like an angle worm. The color receded to practically normal in about a minute as we stood and watched it. I was tempted to sew up the abdomen and leave the appendix in, but did not have enough nerve. The lumen had constrictions in it, and by the proximal one, the mucous membrane was ecchymotic.

Personally, I have several times seen a fully distended appendix as suddenly lose its distention and become flaccid and empty under manipulation while I was removing it. Many surgeons must have had this experience of having the obstructed appendix suddenly emptied during the manipulation of the removal, and doubtless many have felt the concretion in the cecum afterward. Then why does it seem so strange that the accumulating pressure behind the obstruction should drive many, most plugs, out into the cecum?

Obviously, once the obstruction is removed, the recovery will be prompt. Upon removal such an appendix will be found infected: red, congested, inflamed, edematous, hemorrhagic, usually empty, sometimes containing bloody serum and mucus.

The three appendices photographed in Figure 4 illustrate some of the difficulties

in demonstrating the plug. In A (T.M.) the appendix was found at operation entirely empty, the plug, judging from the symptoms, having held about six hours and having been driven out about six hours before operation. B (N.W.) and C (Mrs. H.S.R.), were both removed eighteen hours after onset of the attack and the appendices were both found blocked and distended. The pathology, you will agree, is practically the same except that B and C are further advanced towards necrosis than A. In A the constriction, which was very marked, was at the cecal junction and was left in the ligature and suture which closed the cecum. The pathologist would never see it. In B the constriction is very well marked, and a half-inch of normal appendix entirely free from pathology shows proximal to the constriction. The sharp line of demarcation of pathology at the line of constriction is strikingly illustrated.

In A the evidence in the history was so typical that the plug had given way at a well marked time. The nurse was offered ten dollars for finding the plug which had caused the six-hour obstruction. She produced a fecal mass of about the proper size at the first emptying of the colon five days after operation. It was soft and dried so rapidly that it is hardly a demonstration that this was the identical plug which held that appendix distended. We can say that it is suggestive evidence.

Case B illustrates the variety of obstructing masses one finds and the difficulty of demonstrating a definite plug in some cases. The appendix was removed intact, fully distended, with marked tension to the examining finger. Upon opening it, we found it filled with the usual mass of debris: pus, mucus, fecal masses, traces of blood, but no one distinctive mass which could be charged with having closed the constriction, which was of considerable size. The obstruction and distention were there, demonstrated beyond peradventure before opening, but the obstructing mass was soft and unstable in its consistency, only a mass of debris. A casual search would have failed

to find it. It cannot be left to the pathologist. The man who sees that appendix in situ must demonstrate the obstruction. The distended appendix under tension was proof that the constriction, which is evident in the photograph, was closed by some sort of mass. It was in the appendix when it was opened. This mass was simply a part of the general fecal remains which, with serum and pus, filled the cavity.

Often the obstructing mass is overlooked in a casual search. I have had the experience several times of finding a distended appendix at operation, but failing to find any definite mass or concretion to close the constriction. I can always find the constriction and, when distended, always debris behind it, but I do not always find demonstrable ball valves with pretty concretions.

Case C illustrates another difficulty in demonstrating the obstruction. I nearly lost the concretion which is seen obstructing it at the constriction. The appendix was removed with the obstruction and distention intact. The distention was extreme. When it was opened, there was a rush of bloody pus and debris. The scissors which opened the appendix pushed the concretion into the appendix as it was forced through the constriction, and it required a very careful search to find it floating in the mass of pus and debris. A casual search would certainly have missed it. Again I implore my surgeon friends to make careful search for both the obstruction and the constriction. They are all-important to the understanding of appendicitis, and so easily overlooked.

Note the similarity of pathology in A after six hours of strangulation and infection, and in B and C after eighteen hours of strangulation and infection: in A acute catarrhal appendicitis; in B and C with petechial hemorrhage and beginning necrosis added; in all, inflammation practically confined to the mucosa and submucosa.

Note the distinct line of demarcation between healthy and diseased mucosa at the point of constriction. Can anyone doubt

that strangulation, arrest of circulation, congestion and anoxemia, *distal* to the constriction had been present?



FIG. 5. Appendix which discovered the cause of appendicitis. The concretion made a perfect "ball valve." By manipulation it could be easily displaced and the appendix emptied. Again it could be easily filled with fluid from a bulb syringe; the trap would spring and a perfect, distended gangrenous appendix would result.

Operate early and you will find the distention often and usually a demonstrable plug in the constriction and abundant evidence of strangulation and anoxemia.

*The Obstruction Holds.* All surgeons have experienced the thrill of finding an appendix, as expressed by Dr. Bissell "piping hot." That is, when the abdomen is opened the appendix is found still distended, showing evidence of inflammation, necrosis, and gangrene, often in imminent danger of rupture. The satisfaction of finding such an appendix before it ruptures comes from the chance to rescue one's patient from a catastrophe which is all too common.

Figure 5 is an appendix\* which started me on a study of the causes of acute appendicitis, and of hydraulics generally and particularly of hydraulic vicious circle.

Mechanically, the onset of acute appendicitis is always the same. The plug closes

the constriction, the appendix balloons out with fluid, and the hydraulic pressure of this fluid retards the circulation. In one patient, the obstructing mass passes into the colon. In the other, the obstruction holds, and the hydraulic vicious circle continues its course exactly as it does in abscess. In fact acute appendicitis is acute abscess. In both conditions strangulation is the major fact in the pathology.

The continually increasing pressure in the appendix interferes more and more with the circulation in its walls. The congestion, anoxemia, the virulent growth of bacteria, all confined in this closed pocket, make quick work of the oxygen-demanding tissues. Capillaries, veins, arterioles, arteries, are successively closed by this pressure; strangulated. The pathology is the pathology of strangulation. It centers about blood vessels and blood pressure, hence it is living pathology.

Early in an acutely distended appendix, hemorrhages are common. These are the result of obstruction to the blood stream and the weakening of the vessel walls due to stretching, and necrosis from the toxins of bacteria. Edema of the mucous membrane is a result of the same forces, fluid being forced out of the vessel walls by the pressure behind and the obstruction ahead.

*Clinical Application.* The symptomatology, the history, and the pathology fit perfectly into this mechanical explanation. The patient, apparently in perfect health, discovers he has an abdominal pain, a colic. The appendicular trap has sprung. This first and most characteristic symptom is the result of the peristaltic contraction of the appendix in its efforts to empty itself. This first pain is usually referred to the upper abdomen and is often slight and easily forgotten. Nearly all abdominal disturbances are referred to this region of the solar plexus, especially in their early stages. If, after a few attempts, the appendix succeeds in emptying itself, the patient is relieved, and goes on, often without suspecting appendicitis. He has had appendicular colic.

\* Also illustrated in *J. A. M. A.*, 1904.

The location of this pain is the subject of a great deal of study and is fully covered in the literature. In brief, it is usually referred to the stomach region and is usually first associated with a digestive disturbance. The pain may radiate in all directions, and sometimes at an early stage points to the lower right corner of the abdomen, the appendix region. The fact that the initial pain usually does not begin in the region of the appendix has resulted in the loss of many lives. The trained surgeon has thoroughly learned this, and even the laity is becoming better informed. The peristalsis seems to be communicated to the intestinal tract from the contracting appendix and produces general colic.

*The Exact Hour of Onset.* The most important fact in the history of acute appendicitis is the exact hour of the onset of the attack. Knowing that the rupture occurs within thirty-six or forty-eight hours, we read the stage of the pathology by pinning the clinical and examination findings to this fixed time. Unfortunately, in the beginning, the symptoms are often so slight that it is difficult to fix the time with certainty, but careful quizzing will usually establish the point.

For instance, I asked a little girl when she first felt the stomach-ache. Her father answered for her, "This morning." After two or three more queries, the little girl said, "No Daddy, don't you remember that I had that pain when we climbed the hill yesterday?" It fixed the time of onset in this case, which proved a very important guide in the treatment.

The time normally intervening between the first onset of pain and the rupture of the appendix being so definitely established, and being so short, makes the fixing of this point obviously very important. We cannot urge too strongly the accurate establishment of this time of onset, as it is the cue to the further history and progress of the disease. Without it we are at sea as to the present pathology. I have taken ten or fifteen minutes quizzing to establish this one point. If that can be absolutely fixed, the

further study of the history and picture of the disease is usually easy. Much of the mortality in appendicitis is due to the failure to fix accurately the time of onset. In many cases the obstruction began a day or two days earlier than the time first mentioned by the patient.

Soon after the onset of colic, the pain becomes more of a continuous ache, interrupted frequently by "colicky" attacks. The next important point is to locate the probable time at which the obstruction was automatically relieved by emptying into the colon, if that fortunate event has occurred. This may occur within an hour of the onset, and it may be delayed for twelve or even more hours. Sometimes this point cannot be definitely determined, but in the majority of cases careful quizzing will elicit the story of a decided and comparatively sudden easing of pain, especially that of cramp-like character. A steady ache and a tenderness will continue for hours and days, but the "colicky" cramp-like character of the pain is usually absent after the obstruction has passed out into the colon. In fact, in many cases it ceases instantly, and the time of the passing of the plug can thus be fixed to the minute. The evidence of the peristaltic wave which begins in the appendix and probably spreads over the alimentary canal generally is a colic, and if a distinct history of colic can be elicited from the beginning of the attack to a sudden cessation when the plug leaves the appendix, the pathology can then be definitely read.

This sudden let-up due to emptying of the appendix must be carefully differentiated from the *gradual* easing of pain which follows the deadening effect of the destruction of tissue by the infection and circulatory stasis: in other words, the beginning gangrene. Sometimes this comes on early enough to be confused with the cessation which accompanies the driving out of the obstruction, and sometimes it may in fact develop rather suddenly. This is one pitfall which must be always kept in mind and cannot always be avoided, espe-

cially in young patients or those who are not very clear or accurate in differentiating the character of pain which they suffer. I should be very presumptuous if I stood out for a dogmatic statement that one can *always* be positive as to the time of relief of this obstruction. But the evidence in the majority of cases is sufficiently positive to allow us to say that the probabilities are 10 to 1 that the obstruction has passed into the colon. The urgency of operation obviously turns upon this question. It is always an advantage to the patient to have had his appendix removed, and where there is any doubt, there should be no hesitancy in removing it at once.

The further history when the obstruction does not give way comprises continuing colic, increasing malaise, fever, and toxemia, and the establishment of a constant ache, more or less colicky, in the abdomen, which very commonly is referred to the appendix region as the disease progresses. Then, after twenty-four or thirty-six hours, we have the easing up of the colicky character of the pain and often a very decided subsidence of all pain and the assertion by the patient that he feels very much better. Following this, at approximately thirty-six to forty-eight hours from the time of onset, comes the evidence of rupture of the appendix as the infection spreads to the peritoneum. Often there is quite a lull and a subsidence of all symptoms, and an expression of relief on the part of the patient at the time of the rupture, but the peritoneal infection develops so rapidly that in an hour or two the patient is aware of a new attack, and, if he is discriminating in his evaluation of the character of the pain, he realizes that his abdomen has taken on a very different program.

The eliciting of this information from the patient is very important in making an accurate diagnosis of the condition present, because from now on, probably during the next twenty-four hours, the debate as to the advisability of operation is most acute on the part of the attending physician, the

patient and his friends, and with varying opinions even among expert surgeons. Often there can be no doubt of the condition; in others, all the factors in the case must be very carefully studied in order to determine whether the obstruction has escaped into the colon or whether a rupture has taken place. The most important factor in the case is the history. Fix the hour of onset, the time of the different types of pain, and the times when the character of the pain changed.

It cannot be repeated too often that, once the diagnosis of acute appendicitis is made, more information about the actual condition can be secured from a careful quizzing as to these factors of time and the character of the pain than from any other signs or symptoms. This is not minimizing the importance of the temperature or the question of leucocytosis or the elimination of other diseases. All the diagnostic factors which have piled up around this condition are important and must be evaluated, but for a picture of the actual pathology, the emphasis should be upon the time sequence in the history.

Two terrible scourges have been definitely marked off the unavoidable mortality list by science. There is no longer an excuse for a death from diphtheria or from appendicitis. In the former, give antitoxin, and give it early. In the latter operate and operate early. The diagnosis can and must be made early. Twenty-four hours is the limit. It must be admitted that the rare case presents when this is impossible, but I must repeat that such cases are very seldom encountered.

In appendicitis, this advice will never be realized until medical men and the public generally see obstruction as the cause and realize that the specter of strangulation lurks in every acute "stomach-ache." Appendicitis must be eliminated or established in every case of acute abdominal pain, and it must be done during the *first twenty-four hours from the time of onset*. The patient must be seen every couple of hours until the diagnosis is made. And with this

picture of obstruction and strangulation in mind, operation will be done within these first twenty-four hours. This is the great urgency in this study. For early operation will not be done until the picture is clearly in mind. The tragedies, the tragedies! If we had only operated early! When will the medical profession learn the lesson from these tragedies? In its beginning appendicitis is only a pimple but potentially it is a bomb about to explode in the vulnerable abdomen.

*Pathology of Appendicitis.* From the earliest studies of appendicitis, pathologists have always stressed the changes in the blood vessels. Obstruction, edema, infiltration, hemorrhage, necrosis, and gangrene all play an important part in the pathology, all are evidences of interference with the circulation, and all are illuminated and explained by the hydraulic vicious circle. The variations from simple infiltration in the mild cases to the more profound circulatory disturbances in the necrotic and gangrenous cases only mark the different degrees of the progress. The presence of microscopic hemorrhage, and often considerable amounts of blood found in the early stages, cannot be explained on any other basis than that of mass involvement of the circulation, in the hydraulic vicious circle. It is the pathology of strangulation.

Unfortunately, the pathologist sees the appendix only after it has been removed from its attachment, and he is handicapped in connecting his pathology with the physiology of the circulation; so that his explanation of the circulatory changes is bound to be incomplete. When the appendix is removed, its circulatory system is severed from the hydraulic system of the body and from the standpipe (heart), which has kept up its blood pressure, and consequently from the basis of all physiological activity. The study and correlation of the living physiology of circulation, with the pathology of acute appendicitis is urgently needed.

In 1896 Dieulafoy<sup>12</sup> made the approach to the obstruction theory of the cause of

appendicitis with his designation "cavite close." He said, "Appendicitis is always the result of the transformation of the appendicular canal into a closed cavity."

Since Dieulafoy's time, numerous writers mention stagnation and lack of drainage in the appendix as factors in causing appendicitis, and in a vague way lack of drainage is generally put down as one of the causes. In 1905, I<sup>13</sup> described my ideas of the closed cavity and the method of closure as with a ball valve. I was the first to declare that the circulatory changes were due to the hydraulic pressure within the lumen of the appendix. Also, that the acute onset, and the rapid progress of the disease are the result of mechanical obstruction. I obstructed the appendix in dogs and described the effect of both the temporary and permanent closure. In 1907, I<sup>1</sup> published the results of some experiments demonstrating the arrest of circulation in their walls by distention of hollow viscera.

In 1914, Wilkie<sup>14</sup> reported some experiments on rabbits and cats illustrating his ideas of acute appendicular obstruction. His emphasis was put upon the character of the content of this closed cavity, finding that animals fed chiefly on a diet rich in proteids would develop a more acute and destructive type of infection than those fed on a carbohydrate diet.

Morton<sup>2</sup> describes experiments showing the effect of distention upon hollow viscera. His work was done in studies of intestinal obstruction.

Dragstedt, Lang, and Millet<sup>4</sup> described some similar findings in 1929 and Burget and Martzloff in 1930<sup>3</sup> described some similar experiments in this same line of study.

These authors confirm my explanation of the strangulating effect of distention of hollow viscera.

Recently demonstrations have been made by several investigators of the effect of entirely closing the appendix by ligature or suture in dogs.

Distention, infection, and gangrene have been the results, the effect being practically identical with those observed in experi-

mental loops of bowel. (Dragstedt, Collier and Butterfield<sup>15</sup>—results to be published later.)

If surgeons would repeat the manipulation which started me in this study (see Fig. 5), they would soon be convinced. They should relieve the obstruction by pushing the concretion up into the appendix and at will fill it again with fluid from a syringe. It would make this mechanical closure real to them. Any appendix distended behind a large sized concretion will make the demonstration. It is a picture of what is happening every day.

The infective process is of course the result of the activity and growth of the pathogenic bacteria always present in the appendix in great numbers and variety. Colon bacilli, staphylococci, streptococci, and a host of others, one-half anaerobes, need only an opportunity to become very active. Lack of drainage, anoxemia, open crevices in the mucous membrane and infection are prompt. Millions develop in a few hours.

#### CONCLUSIONS

1. The proximate cause of acute appendicitis is a narrowing of the lumen of the appendix.

2. The immediate cause is a fecal mass or concretion lodging behind the constriction, causing a closed cavity containing a foul, putrefying, infective mass, developing a hydraulic vicious circle.

Further steps and factors are: (a) the cavity fills with fluid to a pressure upward of 30 to 50 to 70 cm. water; (b) this

hydraulic pressure closes the blood vessels in the mucosa and walls (Fig. 2); (c) circulatory stasis results; (d) congestion; (e) effusion, edema; (f) strangulation; (g) anoxemia; and (h) anaerobic mastery and infection, since appendicular bacterial flora is predominantly anaerobic.

*Final Majority:* The rising pressure plus muscular action drives the plug with the foul mass into the colon, leaving perfect drainage, a restored circulation, and prompt recovery from a superficial (catarrhal) appendicitis.

*Minority:* The obstruction holds against all pressure; necrosis, gangrene, rupture, peritonitis, etc., follow. All grades and types are possible from these beginnings.

*Chronic Appendicitis.* Chronic appendicitis has as a rule quite a different pathology. Occasionally inflammation, beginning with an acute attack, will continue to grumble and leave some of the changes commonly noted by pathologists as evidence of chronic appendicitis. However, most of the pathological changes classed as chronic appendicitis are the result of the natural degenerative changes which are constantly active in a vestigial organ.

The appendix in the human is the evolving remnant of a very useful organ in many animals, especially herbivorous. Much infiltration of leucocytes naturally accompanies this degenerative change.

I fear that the report of chronic appendicitis by many pathologists is predicated upon the desire to support the surgeon in his original recommendation of appendectomy.

#### REFERENCES

1. VAN ZWALENBURG, C. Strangulation resulting from distention of hollow viscera; its bearing upon appendicitis, strangulated hernia and gall-bladder disease. *Ann. Surg.*, 46: 780-786, 1907.
2. MORTON, J. J. Differences between high and low intestinal obstruction in the dog. *Arch. Surg.*, 18: 1119-1139, 1929.
3. BURGET, G. E., MARTZLOFF, K., SUCKOW, G., AND THORNTON, R. G. B. Closed intestinal loop; relation of intraloop (jejunum) pressure to clinical condition of animal. *Arch. Surg.*, 21: 829-837, 1930.
4. DRAGSTEDT, C. A., LANG, V. F. AND MILLET, R. F. The relative effects of distention on different portions of the intestine. *Arch. Surg.*, 18: 2257-2263, 1929.
5. OWINGS, J. C., MCINTOSH, C. A., STONE, H. B., AND WEINBERG, J. A. Intra-intestinal pressure in obstruction. *Arch. Surg.*, 17: 507-520, 1928.
6. STONE, H. B. The clinical application of experimental studies in intestinal obstruction. *Am. J. Surg.*, 1: 282-283, 1926.
7. WEINBERG, M. Personal communication.  
[For remainder of References see p. 450.]

# SLOUGH PREVENTION IN THE INJECTION TREATMENT OF VARICOSE VEINS

BY A NEW DYE METHOD\*

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ONE of the complications that is greatly dreaded in the injection treatment for varicose veins is the occurrence of slough formation.

A slough or area of wet gangrene is due usually to the accidental injection of irritating fluid outside of the vein. No solution as used at the present time is free from this danger. Even the newcomer to the group of vascular irritants, sodium morrhuate, has been reported as capable of producing a slough. Knowing that we cannot depend upon any solution to avoid local necrosis, we are forced to rely upon faultless technique in order to avoid this complication. However, even with apparently good technique, a perivascular injection can be made without the operator's knowledge. This is illustrated in Figure 1.

In Figure 1A, the needle is in the vein and on sucking back with the syringe blood is aspirated. However, the vein has been punctured in several places during the search for its lumen, and solution may escape through these holes to cause a slough. In B, the needle point lies in a hematoma caused by a stab in the vein wall. Blood returns on aspiration to deceive the operator. In C, the needle has not been wiped free from excess fluid and some will be deposited in the needle track on entering the tissues. In D, a long bevel needle is partly in and partly out of the vein. The fluid finds its way outside the vein, but aspiration draws blood. In E, a thin-walled vein has been torn after having been pierced by the needle. A leak in the vein wall is the result.

It can thus be seen how a perivascular injection can be made in the face of

apparently good technique. The operator often cannot definitely know that an accident has occurred and will neglect to neutralize an offending escaped solution; a slough may be the result. The problem, therefore, is to be able to detect the immediate introduction of fluid outside of the vein. The dye method was developed to answer this need.

## PRINCIPLE

Methylene blue is incorporated in the injecting solution so that any escape of fluid into the tissues demonstrates itself as a dark stain. In the preliminary trial of this method we worked with a 40 per cent solution of sodium salicylate. Using such a strong irritant was considered a severe test of this new technique.

## ARMAMENTARIUM

Two salicylate solutions are prepared: one, the usual 40 per cent solution in sterile distilled water; the other, the same solution containing in addition 0.4 per cent methylene blue. This sterile colored mixture is kept in a rubber-stoppered bottle of the type that vaccines are dispensed in. When fluid is needed for injection, it is secured by piercing the rubber stopper, thus keeping the remainder of the mixture sterile.

The syringe is a B-D intravenous type, of 3 or 10 c.c. size. This syringe, as illustrated, is so constructed that the tip, which is at an angle to the barrel, has in it a small bulbous dilatation. The bulb is in communication with the barrel by a small capillary channel. This arrangement prevents the mixture of the contents in the two chambers. As will be shown later, the

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separation of the contents of barrel and bulbar tip is an important mechanism of the dye method. The smaller 3 c.c. intra-

aspirated. This is about one-half of the total amount of salicylate to be used. After this the air is expelled from the syringe, and

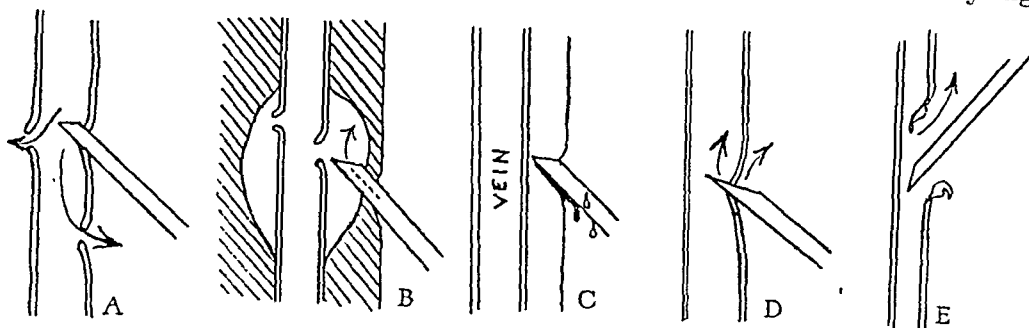


FIG. 1.

venous syringe will soon be available to the profession. It has been made at our request in order to fill a need for a small instrument of this type and will be found generally

the needle wiped clean with an alcohol sponge.

2. Then the colorless salicylate solution is sucked up from a sterile medicine glass. It is important to do this very slowly so that no air is aspirated. Enough of this solution is drawn up to make a total of 3-4 c.c. in the syringe. During this procedure the syringe is held perpendicularly with the needle pointing down. As this is done, it will be seen that the bulb in the syringe tip becomes decolorized while the colored mixture is drawn up into the barrel. When we finish, we have in the same syringe a colorless and a blue solution, each segregated into different compartments, which do not mix.

3. The needle tip is wiped off with an alcohol sponge and the injection made as usual.

Upon entering the vein, blood is aspirated into the capillary bulb of the syringe tip, where it can be distinctly seen against the background of the colorless salicylate solution. As the injection is made, a blue stain around the needle area is a signal that fluid is entering the perivascular tissues. This is a signal to stop the injection. If no discoloration is noted, we wait thirty seconds and then withdraw the needle. Further treatment is as usual.

In the event of a perivascular accident, the first step is to aspirate in the hope of sucking back some of the escaped fluid.

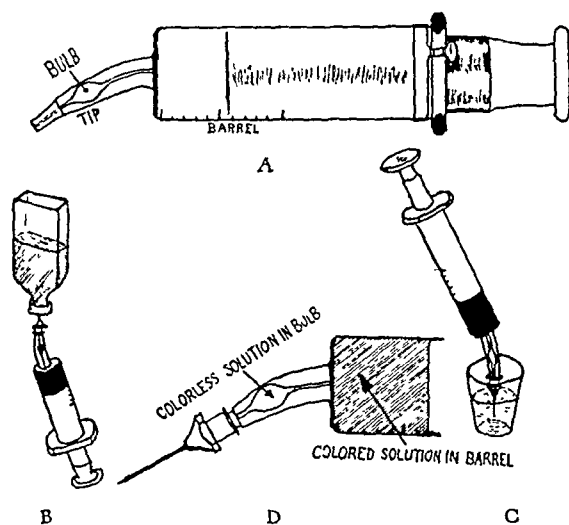


FIG. 2. A. Construction of empty syringe. B. Aspiration of dye-colored solution from bottle. C. Sucking up colorless solution from medicine glass. D. Shows final result of mixture in syringe.

useful where varicose vein injections are called for.

The needles are of the short-bevel type, 21 or 23 gauge, and preferably made of steel.

#### TECHNIQUE (FIG. 2)

1. The needle with syringe attached is plunged through the rubber stopper and 1-2 c.c. of the dye-colored solution is

Then the bluish area is flooded widely with at least 10 c.c. of normal saline solution or distilled water. Distilled water is thought by some to be a better diluent, but it must not be injected into the vein. Neutralization will not always prevent a slough. However, with the guidance of the dye, a poor injection will be promptly stopped and a minimal amount of tissue destruction will result. Prompt dilution of the small amount of escaped fluid will therefore exercise its greatest benefit. In our experience, no sloughs have resulted where the blue discoloration, indicative of an extravascular injection, has been promptly neutralized.

An interesting phenomenon takes place as the injection is made. This is the appearance of the colored fluid as it is seen traveling through the varicose veins. The solution can actually be visualized as it courses through the venous channels. The flow is usually downward, and sometimes both up and down. As it moves downward it spreads through the smaller veins where it lingers to subside slowly. During its diffusion over the surface vessels of the leg, the patient experiences a cramp-like pain. This observation shows that the cramp resulting from irritating injections is not due to vascular or muscular spasm. The pain apparently depends upon the irritation of a sufficiently wide bed of venous channels. As a further proof, we have noted that when the fluid is localized to a vein segment by pressure, no

cramp occurs until the pressure is relieved and the fluid allowed to spread through the network of smaller superficial veins. The

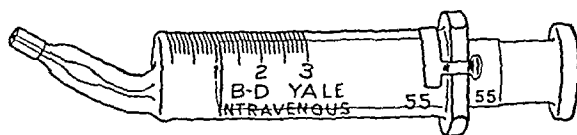


FIG. 3. New 3 c.c. varicose vein syringe, as suggested by author, and used in this technique.

amount of downward flow is roughly proportionate to the degree of varicosity.

At the German Polyclinic Hospital we have used this method for the past year in 72 cases, employing it whenever sodium salicylate was indicated. In addition to salicylates, of course, we use all other solutions. Our rule is to use the least irritating solution that will produce the desired effect. In the future, we hope to extend the dye method to other irritating preparations.

#### CONCLUSION

1. The avoidance of sloughs, in the light of our present knowledge, depends less upon solutions than upon technique.
2. Even with apparently good technique, sloughs may occur, because a perivascular injection can be made without the operator's knowledge.
3. With the dye method of injection, we have a definite indicator of a perivascular accident. This is a signal to stop the injection and neutralize.

#### BIBLIOGRAPHY

1. HIGGINS, T. T., and KITTEL, P. B. Injection treatment with sodium morrhuate. *Lancet*, 1: 68-69, 1930.
2. PORRITT, A. E. Varicocele-injection treatment. *Proc. Roy. Soc. Med. (Sect. Surg.)*, 24: 81-85, 1931.
3. BURTON, C. C. Complications following injection treatment. *U. S. Vet. Bur. M. Bull.*, 6: 854, 1930.
4. KILBOURNE, N. J. Varicose vein slough (following injection therapy). *J. A. M. A.*, 95: 787, 1930.
5. MCPHEETERS, H. O., and RICE, C. O. Circulation and direction of venous flow; experimental proof. *Surg. Gynec. Obst.*, 49: 29-33, 1929.
6. MILLER, A. A. New syringe for injecting sclerosing solutions. *Lancet*, 2: 452, 1928.
7. MCPHEETERS, H. O. *Varicose Veins*. Ed. 2, Phila., Davis, 1930.
8. DETAKATS, G. Varicose veins: treatment, causes of failure. *J. A. M. A.*, 96: 1111, 1931.



# INJECTION TREATMENT FOR VARICOSE VEINS

WITH SPECIAL REFERENCE TO ATTENDING DANGERS AND COMPLICATIONS.  
REPORT OF A CASE OF CONGENITAL ARTERIOVENOUS FISTULA\*

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DES MOINES, IOWA

THE phenomenal success of the treatment of varicose veins by the injections of escharotic solutions has

of treatment. The injection method relieves the patient of all dread of anesthesia, the mental terror of operation, and hospital



FIG. 1. H. R. McG. Congenital arteriovenous fistula, right lower extremity. Note enormously enlarged veins of dorsum of foot and anterior aspect of leg and thigh. Other equally enlarged veins on outer and posterior surfaces not shown in picture. Note further, normal left lower extremity.

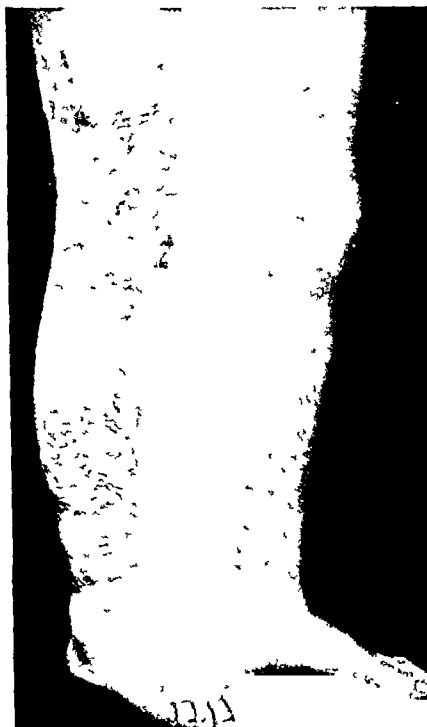


FIG. 2. H. R. McG. After treatment. All vessels obliterated by use of massive doses of quinine and urethane.

become so well established that this method has practically displaced all other procedures. The voluminous literature that has appeared in the two or three years last past is so convincing of the superiority of the injection method over that of operative measures, that seldom can anyone now be found to defend any of the older methods

confinement and permits him to continue his accustomed vocation, and reduces the total expenses at least one half.

The mortality rate following excision as shown by Kilbourne<sup>1</sup> was one in 250 or 0.4 per cent. Kilbourne's record was derived from a questionnaire submitted to thirty-four large hospitals with a total of 4607 cases surveyed and a mortality of 16, 8 of which were due to embolism. McPheeters and Rice,<sup>2</sup> on the other hand, collected

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reports on upwards of 53,000 cases treated by the injection method with 11 deaths or about 2 in 5000. Some of the deaths in

Manufacturers of bandages, pharmaceuticals, etc., have culled from this literature paragraphs best suited to their purpose,

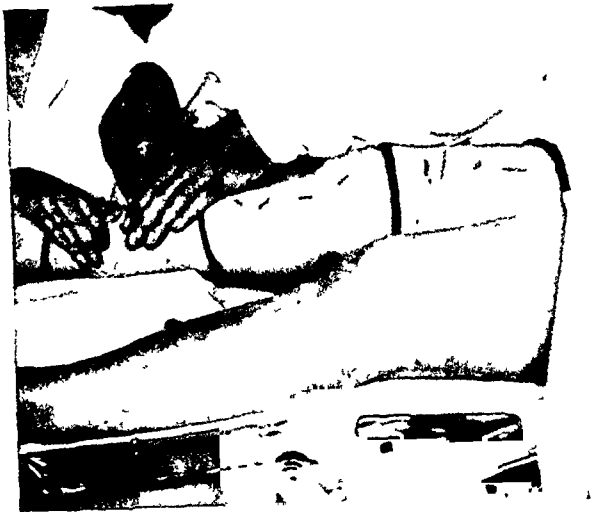


FIG. 3. Sites for injections are marked with mercurochrome solution. With patient in prone position, limb is elevated to a right angle with body to empty veins by gravity. Rubber tubes are then applied and injections are made with leg lying on table, while assistant aids in forcing remaining blood into area to be injected.

Kilbourne's cases undoubtedly were due to sepsis, as the records examined ran back as far as the year 1872. Should critical evaluation be made of the methods, the comparative risks of the two procedures would more nearly approach each other if only the work of skilled operators in modern hospitals were taken on the one hand, as compared with the injection work that is being done in the average physician's office; for it is conceded by all to be an office procedure. It must be borne in mind that the cases reported by McPheeters were taken almost entirely from foreign clinics, the injections having been done under more or less ideal surroundings, mostly by expert technicians, as compared with much of the work that is being done at the present time under more or less handicapping conditions and unfavorable surroundings. The overwhelming assurance of the safety of this treatment as set forth in the foregoing statistics has been confirmed by much of the recent literature.



FIG. 4.

FIG. 4. J. P. W. Barber, aged fifty-five. Typical case of varicose veins, twenty years' standing. He was unable to work at his trade continuously, on account of pain. Veins were completely obliterated within a fortnight, since which time he has followed his vocation full time in comfort.

FIG. 5.

FIG. 5. Same case as Figure 4, nine months after treatment.

and in the form of brochures, have freely supplied the profession with the knowledge of the requisite equipment and modus operandi of the treatment, and it has led to a more or less indiscriminate use of the intravenous treatment even by the cultists. One of the cases followed by death reported below is alleged to have been treated by an osteopath. The case with which the treatment can be administered and the avidity with which it has been taken up by the profession, have brought words of warning from nearly every leading clinician engaged in the treatment; lest this valuable means of cure be cast into disrepute through individuals undertaking it without

thoroughly familiarizing themselves with the principles underlying the causation and pathology, and particularly in neglect-

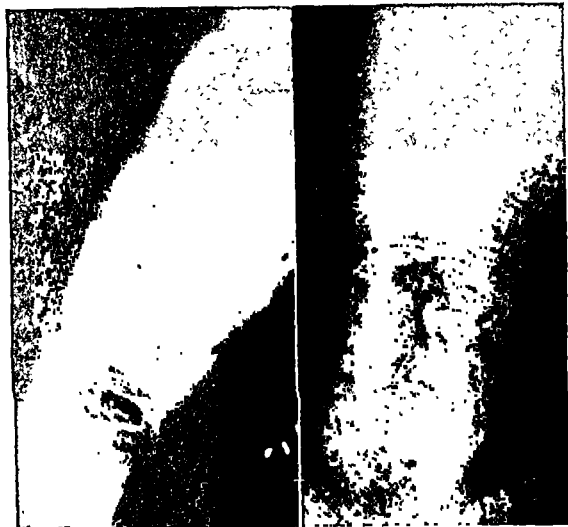


FIG. 6.

FIG. 7.

FIG. 6. Mrs. F. M., aged forty-three. Phlegmasia albadolens fourteen years ago. Similar ulcer on same leg, inner aspect, directly opposite one shown. Not injected but treated with rubber sponges and A. C. E. bandages.

FIG. 7. Same case as Figure 6 four weeks after treatment was begun. She was advised to continue to wear the bandage. There has been no return of ulcers of two years' standing.

ing the determining factors necessary to the proper selection of cases.

Of the complications following either the operative or injection method of treatment, embolism is the outstanding danger to be feared. Only 4 fatal cases of pulmonary embolism were reported in the 53,000 compiled by McPheeters and Rice. In his series of 15,000 cases, Prof. K. Linser is said never to have observed a fatal embolism. Thornhill<sup>3</sup> reported over 20,000 cases that had been injected by European surgeons, among them being Linser, 6000; Genevieve, 4000; Nobl, 3000; Douthwait, 2000; Jaugier, Sicard, and Forestier, more than 3000, none of whom reported fatalities from embolism. These statistics would indicate that embolism is a negligible factor. The fact, however, that 3 non-fatal cases of embolism occurred in my own practice, when I had treated less than 400

cases, in which not exceeding 2500 treatments were given, and that 4 deaths in various parts of Iowa were said to have occurred following the administration of the injection treatment, opens the question as to the accuracy of the common assertion that the injection method is entirely without danger.

Of the 4 deaths, 2 were verified by physicians in attendance on the cases as having died from pulmonary embolism. It must be admitted, however, that in but one case has it been possible to obtain an accurate history or report from the physicians who administered the treatment. In this case, the death unquestionably was due to embolism. Autopsy was made on none of the cases, but all the deaths followed within thirty days after the administration of the treatment, and 3 at least were reported to have suffered all the characteristic symptoms of pulmonary embolism, which leaves little doubt as to the cause of death in any of these cases. The fourth case brought to my attention is largely hear-say. My letter requesting information concerning the death, addressed to the doctor who is said to have treated the patient, was not answered. The fact that all the cases mentioned have come to my attention unsolicited and facts pertaining to the accidents have not been voluntarily forthcoming would indicate that doctors are unwilling to report the fatal accidents that have followed the treatment. These fatalities have prompted me to bring the question of embolism to the attention of the profession and to consider, also, some of the other complications more or less frequently encountered in the treatment.

During the early years of the treatment, when the stronger escharotic solutions, such as mercury salts and sodium carbonate, were used, sloughs were of common occurrence. If any of either of these solutions escaped outside the vein during the injection, a slough was inevitable. Consequently, they were early abandoned for sodium chloride and sodium salicylate, the

milder solutions. However, sodium chloride and sodium salicylate were frequently found to cause marked sloughs. Any of the escharotics thus far used will produce a more or less severe reaction if, during the process of injecting the vein, any of the solution finds its way into the subcutaneous tissues. Even the sugar solutions and sugar combinations now being used, if partly injected outside the vein, will result in a more or less severe reaction. Normal salt solution and distilled water are the only solutions that may be injected with impunity without incurring the risk of more or less destruction of the tissues. One of these should be injected freely into the area in sufficient amount to dilute the solution, should any of the escharotic be accidentally injected outside the vein. Owing to the free mobility of the varicose vein, embedded as it is in the loose subcutaneous tissue, it is more difficult to puncture than the normal vein. In attempting the injection, the needle may transfix the vein, as evidenced by the column of blood showing in the syringe only when the needle is being withdrawn after puncturing the vein. When this accident happens, some surgeons advise removing the needle and injecting at another site; however, if one waits a few moments, until the vein contracts, and then injects slowly so that very little intravenous pressure is exerted, one may safely proceed without removing the needle. It is advisable to use the milder sugar solutions or combinations of sugar and soda salts until one has become proficient in the work. The sodium salts are much more effective than any of the sugar solutions and must often be resorted to in order to procure a permanent blocking of the veins. Sloughs, when they occur, should be excised at once or treated with Dakin's solution until the necrotic core is separated, after which adhesive strapping, to coapt the walls, should be resorted to. Excision of the slough should not be attempted outside of the operating room of a hospital.

One case of metastatic infection occurred in my practice in a woman fifty years of

age. Several localized abscesses below the knee formed that required incision and drainage. An initial chill with a temperature of  $104^{\circ}$  followed eighteen hours after the injection of a 40 per cent solution of sodium salicylate. The patient made a complete recovery and most of the varicosities and the varicose ulcer were cured; but the patient was confined to the hospital for three weeks. I am at a loss to account for the origin of the infection. The injection was done in the operating room of the hospital where all patients were being treated at that time and were given the regular preoperative preparation and every precaution was taken for carrying out the established aseptic technique.

I am more than ever convinced of the importance of strict asepsis in carrying out this treatment. Particular attention should be given to preparing the sites for injection. This should include shaving the hair when necessary, scrubbing with soap and water, and finally with 70 per cent alcohol. The sites for the injections are marked with mercurochrome which also fortifies against the introduction of infection. Not until I had equipped a special office operating room, with all necessary accessories, and procured competent assistance, was I willing to undertake this work outside the hospital.

At Broadlawns City Hospital, where much of the work is being done, no patient is subjected to treatment until a complete physical examination has been made, and if ulcers are present, a Kahn or Wassermann blood examination is made. Trendelenburg and von Perthe's modification reactions are observed in all my cases, and if there is suspicion that the deep return circulation is not functioning, the patient is made to walk several blocks with the leg securely bandaged up to the knee. If, upon his return, no discomfort is felt, the treatment may be safely advised. If, on the other hand, discomfort and pain result, relieved by the removal of the bandage, the treatment should not be administered. In such a case the varicosities are compensatory.

Arteriovenous fistula of the lower extremity is found but rarely. The condition, however, must be borne in mind and not confounded with varicose veins of the ordinary type. But few cases, I believe, of the aneurysmal type of varicose vein are benefited by the injection treatment. Since the classic works of Reid<sup>4</sup> on arteriovenous communications and the widespread use of the injection treatment for varicose veins, much interest has been aroused in these circulatory malformations, and special search has been carried on in various clinics. Horton<sup>5</sup> reports 23 cases of congenital arteriovenous fistula of the extremities observed at the Mayo Clinic from June 28, 1929 to May 11, 1931. The following case (Figs. 1 and 2) is especially interesting.

H. R. McG., aged twenty, was referred to me by Doctor Lovejoy for varicose vein treatment of the right leg. The enlargement of the veins of the right lower extremity was noticed by his parents at the time he began to stand alone and walk, and they have continued to increase in number and size up to the present time. Many of the veins are of the cavernous variety, being large pockets filled with blood, 2 cm. or more in diameter. The veins of the dorsum of the foot are as large as one's little finger. Three toes show birth marks on the plantar surfaces and the skin on the external aspect of the thigh just above the knee shows a reddish purple flammeus, the size of one's hand, also present at birth. No bruits, thrills, or pulsations are perceptible anywhere along the affected extremity. Blood drawn from a vein at the elbow is distinctly darker in color than that taken from the enlarged veins of the affected leg. The limb is increased in circumference from one to 5 cm., over that of the left leg, which is normal in all respects. The length of the affected limb, however, is not increased. A roentgenogram of the heart indicates that there is no enlargement of that organ and the pulse is normal. In all other respects, he is physically almost perfect and has suffered but little inconvenience on account of the defect. By the use of large doses of escharotics we have obtained the closure of many of the veins below the knee. He is still under treatment.

Perivenitis, first described by Sicard, is a distressing complication that occasionally arises after an injection. It may involve the total length of the long saphenous vein, and is more apt to occur in very extensive and extremely large varicosities. In large, extensive varicosities, one should not undertake to close too large a group of veins at any one sitting, and the solution should be confined to a comparatively small area for a period of ten minutes, then rapidly drained out by elevating the leg. My 3 cases of pulmonary embolism were preceded by perivenitis, one of which was very marked. These 3 non-fatal cases of pulmonary embolism presented all the cardinal symptoms of embolism and there could be no doubt as to the correctness of the diagnosis. Some months ago in a personal interview, Dr. McPheeters informed me that he had never had a non-fatal embolism in his practice. Emboli not sufficiently large to occlude the pulmonary artery, therefore, must be regarded as infrequent; however, in view of my own experience, it must be conceded that the accident is not as rare as statistics would lead one to believe. It is my opinion that embolism, when it occurs, is the result of infection, since the clot resulting from injection, under normal condition, clings to the injured vein wall and is tough and tenacious, possessing no tendency whatever to break up as does the loose, friable, infected clot lying loosely within the vein.

The question naturally arises; what can be done to prevent embolism? It is evidently impossible to anticipate in every case conditions that will determine the formation of embolus. Painsstaking effort, however, should always be made to obtain a history of any former circulatory disturbance, such as an attack of thrombophlebitis, phlegmasia alba dolens, or thromboangiitis obliterans (Buerger's disease). The safety of injecting patients that have suffered from any of these conditions is very questionable indeed.

It is well known that recurrence from the thrombophlebitis may take place after

varying periods, up to three or more years; and the dormant infection may easily be aroused by the sudden insult to the vein produced by an injection, which would be the signal for the whole system of varicose veins of that extremity to become involved, and their lumen filled with pathological clots. Some surgeons, however, believe it safe to inject such cases after a year.

While it is apparent that statistics are misleading and that the dangers attending the injection treatment are underestimated, I am none the less enthusiastic in my support of it, in properly selected cases. It is one of the safest procedures in surgical practice. The edema that sometimes follows the injection may excite the patient but it need not cause the surgeon any anxiety, provided the deep return circulation tests have shown these veins to be functioning normally. A 4 inch A. C. E. bandage should be used until the treatment is completed. This helps to overcome the swelling and the pain. It should be borne in mind that none of the escharotics used are clot-producing agents. Their contact with the intima produces an eschar and the clot is formed slowly long after the solution itself has been dissipated into the circulation. The cauterizing process takes place almost instantly and should be completed within two or three minutes, provided the vein has been emptied of most of its blood before the solution is thrown in. The success of the treatment, indeed, depends upon the completeness with which the vein is emptied of its blood and the care with which the solution is confined to a definite area. This may be done in various ways. I frequently use a  $\frac{3}{16}$  inch, pure gum rubber tube drawn about the leg above and below the point where the puncture is to be made, while the extremity is held by an assistant at right angle to the trunk to empty the veins, with the patient in the prone position. (Fig. 3.)

It is no longer considered dangerous to inject varicosities of the pregnant woman or of diabetics. The pregnant woman, up to the sixth month, may be treated and

relieved of much suffering during the latter weeks of pregnancy. Diabetics may be safely treated after a short course of insulin.

The permanency of the injection treatment was an interesting and vital question for some years after the treatment was first introduced, more than ten years ago. This question was recently discussed by Howard, Jackson and Mahon<sup>6</sup> and the startling statement made that there were 98 per cent of recurrences in their cases following a year or more. Except in the very early cases done for esthetic reasons, they advocate a return to the old method of excision, or excision and injection. Their statement of recurrences does not conform with my experience. Neither does it appear to be in accord with the accepted reports of clinicians, here or abroad. Indeed, I am not aware of a single failure, that is, a complete recurrence or recanalization of the veins treated by injection. It is true that quite a large percentage of patients return a few weeks after injection, with islands of varicosities here and there, mostly new veins, enlarged, that require attention; "mopping up process" as I have termed it. And then again, during the treatment one occasionally sees blue veins beneath the skin, apparently insignificant and of no importance, yet in a few months these may become enlarged varicose veins. Neither of these conditions, in my opinion, should be classed as a recurrence or failure of the injection treatment. Apparently the San Francisco men have done this very thing.

Varicose veins are a progressive, degenerative process, and it is not possible always to say just when our cases have been completely treated. I have, therefore, always insisted on patients returning for observation at intervals for a year or more after treatment. Dr. H. O. McPheeters, in a personal communication, likens the varicose veins state to decayed teeth. He says, "A patient may have all his teeth filled, but decay will continue and the patient will have more decayed teeth



at the end of two years, even though all his teeth were in good condition previously." Usually these veins are readily obliterated by repeating the injection, using one of the standard solutions. Almost without exception, our patients are happy and satisfied with the results obtained, even though they do come back at the end of six months or a year with a few scattered loops of veins. The simple matter of injecting these veins, even though a third series of injections is required, is preferable to excision with all its uncertainties and attendant dangers, to say nothing of the time lost and the additional hospital expenses incurred.

#### CONCLUSIONS AND SUMMARY

The injection treatment has superseded all other measures and it is considered to be one of the safest of all surgical procedures. The danger of embolism, however, is undoubtedly underestimated and is to be reckoned with. This accident should be reduced to a minimum by a familiarity with the conditions underlying the diseased

processes, including the etiology and pathology, and one should be prepared to carry out and interpret all the necessary tests essential to proper selection of cases.

There is no one ideal solution in use that is always effective or fool-proof. Should a slough result, I prefer to treat it conservatively, bringing the walls together with adhesive strips after the separation of the necrotic core. Radical excision of the slough should be done only in a hospital operating room.

A complete physical examination of the patient and careful preparation of the limb is essential before any injection is attempted. At the present time, however, we know of no infallible means of preventing certain serious reactions and even grave disasters that occasionally follow the treatment.

Recanalization of injected veins may occur and varicosities may develop from apparently normal veins after injection and will require treatment. All patients, therefore, should be kept under observation for a year or longer.

#### REFERENCES

1. Kilbourne, N. J. Treatment of varicose veins of the legs, consideration of safety. *J. A. M. A.*, 92: 1320-1423, 1929.
2. McPHEETERS, H. O., and RICE, C. O. Complications, direct and associated following injection treatment of varicose veins. *J. A. M. A.*, 91: 1090-1094, 1928.
3. THORNHILL, R. Treatment of varicose veins by injection method. *Practitioner*, 120: 54-58, 1928.
4. REID, M. R. Study of abnormal arteriovenous communications, acquired and congenital. *Arch. Surg.*, 10: 602-638; 996-1009, 1925. 11: 25-42; 236-253, 1925.
5. HORTON, B. T. Hemihypertrophy of the extremities associated with congenital arteriovenous fistula. *Proc. Staff Meetings Mayo Clin.* May 27, 1931.
6. HOWARD, N. J., JACKSON, C. R., and MAHON, E. J. *Arch. Surg.*, 22: 353, 1931.



#### REFERENCES OF DR. VAN ZWALENBURG\*

8. HALDANE, J. B. S. Possible Worlds and Other Papers. N. Y., Harper, 1928.
9. WEINBERG, M., PRÉVOT, A. R., DAVESNE, J. and RENARD, C. Recherches sur la bactériologie et la sérothérapie des appendicites aiguës. *Ann. d. l'Inst. Pasteur*, 42: 1167-1241, 1928.
10. WILKIE, D. P. D. Personal communication.
11. BISSELL, A. H. Personal communication.
12. DIEULAFOY. De l'appendicite. *Abs.: Progres Méd.*, 3: 170, 1896.
13. VAN ZWALENBURG, C. Appendicitis. Some points in its diagnosis and treatment from the viewpoint that its cause is a strangulation produced by distention behind a ball-valve. *Calif. & West. Med.*, 3: 14-16, 1905.
14. WILKIE, D. P. D. Acute appendicitis and acute appendicular obstruction. *Brit. M. J.*, 2: 959-962, 1914.
15. Personal communications.

\* Continued from p. 440.

# THE PRESENT DAY STATUS OF ANESTHETIC AGENTS\*

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**A**N investigation into the status of the various anesthetic agents must, of necessity, include a study of their actions on bodily structures and functions as well as a study of the explosiveness, controllability, and other characteristics peculiar to the agents themselves which may benefit or harm the human mechanism.

## ACTION OF THE MORE COMMON ANESTHETIC AGENTS ON BODY STRUCTURES

**CARDIOVASCULAR SYSTEM:** Severe interference with the cardiovascular system is probably the most important cause of death immediately following operation. The term "surgical shock" is applied to that combination of symptoms manifested by a severe lowering of the blood pressure, a narrowing of the pulse pressure and a great increase in pulse rate. Any agent which would alter the blood pressure and pulse rate picture in this direction, if prolonged, may be said to be conducive to surgical shock.

Ether, because of its cardiac stimulation in good risk patients, produces an increase in the pulse rate associated with a corresponding rise in the blood pressure. If long continued, especially in poor risk patients, the pulse rate will remain high and the blood pressure fall.

A nitrous oxide induction is usually marked by an increase in pulse rate associated with a rise in blood pressure a little greater than the rise in pulse rate would seem to warrant. This latter is attributed, by some, to a so-called "vascular spasm."

Ethylene occasions very much the same response as does nitrous oxide. The pulse rate climbs a little less high than under nitrous oxide. The average increase in

systolic pressure is about 14.1 per cent and the pulse pressure about 31.4 per cent above the previous normal.<sup>9</sup>

The barbiturates, as a group, cause a moderate fall in blood pressure and an increase in pulse rate. This action, however, is transitory.<sup>35</sup> The fall in blood pressure under sodium amytal has been variously reported as between 15-30 mm. Hg,<sup>70</sup> 32 mm.<sup>76</sup> and 40-60 mm.<sup>21</sup> There exists the report of a case where the pressure fell from 210 to 60 mm. Hg.<sup>21</sup> Falls in blood pressure occurring under pernocton are not as great. The author, in a series of pernocton anesthetics, concludes that the average fall is between 5-20 mm. Hg. There were no cases where the fall varied widely from this average.

Avertin (tribromomethyl alcohol) anesthesia is usually associated with a fall in blood pressure between 10-20 mm. Hg.<sup>39</sup> There is associated no, or at the most a very slight, increase in pulse rate. This fall in blood pressure is temporary.

Regional anesthesia,\* unassociated with the use of epinephrine in the anesthetic solution, does not alter the blood pressure-pulse rate picture per se. Associated with epinephrine there results a change responsible to this solution.

Spinal anesthesia presents a change in the blood pressure and pulse rate that no other agent produces. The fall in blood pressure is rapid and lasts throughout the duration of the anesthesia. The pulse rate falls considerably but in 80 per cent of the cases maintains a normal relationship to the systolic and diastolic pressures.<sup>93</sup> This

\* In the strict interpretation, regional anesthesia embraces spinal anesthesia, but since spinal anesthesia presents characteristics peculiar to itself it will be considered separately in this paper.

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fall in pulse rate associated with the fall in blood pressure is felt to act as a prophylactic to surgical shock as long as the

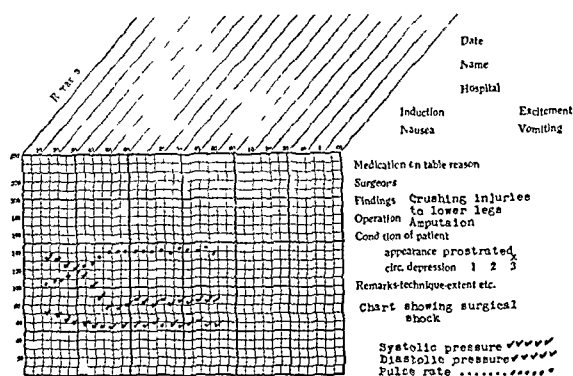


FIG. 1. Surgical shock

normal blood pressure-pulse rate ratio is maintained.<sup>93</sup>

**PULMONARY SYSTEM:** The induction of ether anesthesia is characterized by an increase in respiratory rate. In anesthetic doses the amplitude is increased. Overdose is responsible for a marked diminution in rate and amplitude. Locally, ether acts as an irritant and tends to produce postoperative pulmonary complications.

The gases, ethylene and nitrous oxide, are also responsible for an increase in rate and amplitude. This is probably due to the great amount of rebreathing usually employed. The rate and amplitude can be altered if the carbon dioxide in the expired air is filtered out by a soda lime container installed in the apparatus. Both these agents are administered with a minimum of oxygen. This is true particularly with nitrous oxide. Ethylene can be administered with a larger amount of oxygen than can nitrous oxide. These gases have no direct irritant action on pulmonary mucosa.

A diminution in the rate and amplitude of respiration is always present in anesthesia resulting from barbituric acid derivatives. This respiratory depression is probably the result of action directly on the central nervous system.<sup>15,84,115</sup> The extreme quiet which follows the administration of a barbituric acid derivative is reported as increasing the likelihood of postoperative pneumonia.<sup>16</sup>

Theoretically, this may be so; but no figures have been advanced to substantiate this statement. If it were true, administra-

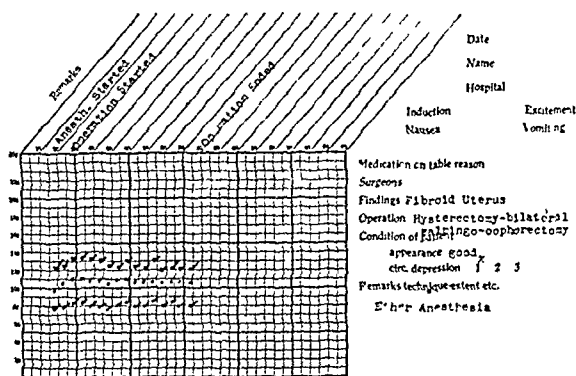


FIG. 2. Ether anesthesia.

tion of carbon dioxide-oxygen mixtures and frequent changing of the patient's position would obviate it. A shorter acting barbiturate would be indicated in a case where pulmonary complications are to be feared in favor of a longer acting one, as sodium amytal. Overdose of barbiturates may be followed by pulmonary edema.

A moderate amount of respiratory depression exists under avertin anesthesia. This respiratory depression is unassociated with cyanosis or pallor. The respiratory mechanism responds readily to carbon dioxide-oxygen mixtures.

The use of cocaine, novocaine or allied agents in peripheral nerve block is unaccompanied by any marked change in respiration. Overdosage, accidental intravenous injection or idiosyncrasy to the agent may be followed by acute intoxication. This manifests itself by a convulsive seizure including the musculature of the respiratory mechanism. Spasm of the respiratory muscles interferes with satisfactory respiration. If the attack is severe or prolonged death results from asphyxia.

Spinal anesthesia results in a definite and great respiratory depression. A decrease in rate and amplitude is present. This is associated with no cyanosis but pallor may occur. The depression is the result of the predominating influence of the vagi over the paralyzed accelerator sympathetic nerves.

**LIVER:** Ether has a marked depressive action on the liver. It has been shown<sup>90</sup> that a two-hour ether anesthesia results in a dye

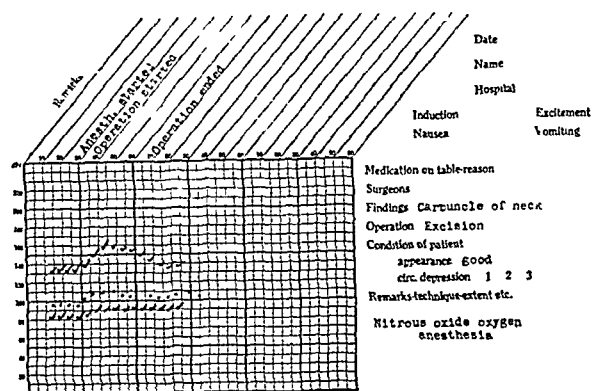


FIG. 3. Nitrous oxide oxygen anesthesia.

retention of 14 per cent. It is responsible for marked tissue change in this structure.<sup>103,121</sup>

The gases in the presence of large amounts of oxygen (17–25 per cent) produce no liver changes. The administration of the gases associated with anoxemia produces liver disturbance.<sup>90</sup> Ethylene, however, is responsible for less damage than is nitrous oxide.

The barbiturates have no deleterious action on liver function and produce no tissue changes in this structure.<sup>6</sup>

The damage to liver function under avertin anesthesia is negligible and compares favorably with the barbiturates.<sup>6,8</sup> Avertin is decomposed in the liver.<sup>31</sup> Overdose, because of this, may result in liver damage.

Regional anesthesia exerts no toxic action on this structure<sup>31</sup> in spite of the fact that the agents used for regional anesthesia are broken down in the liver.

Chloroform, like ethyl chloride, exerts a marked toxic action on the liver. Evidence is indisputable that chloroform poisoning is synonymous with chloroform anesthesia.<sup>90</sup>

**KIDNEYS:** Deep ether anesthesia markedly inhibits kidney function and may produce tissue changes in this organ.<sup>103,121</sup>

Ethylene is responsible for no kidney damage.<sup>9</sup> The same holds true for nitrous oxide.

The barbituric acid derivatives are excreted through the kidneys. They have no detrimental effect on this organ, how-

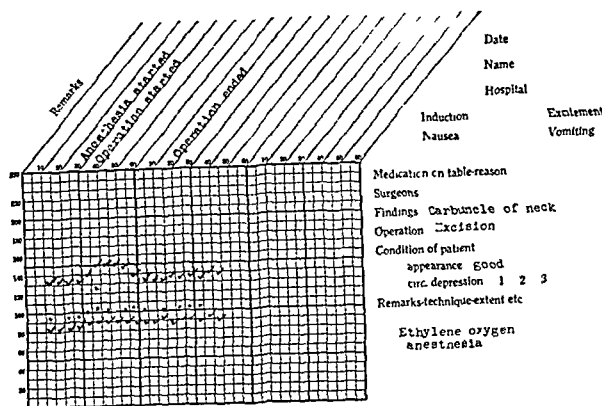


FIG. 4. Ethylene oxygen anesthesia.

ever.<sup>55</sup> Enge and Hoffman<sup>19</sup> feel that sodium amytal is responsible for an actual and relative depression of urinary output. Phenolsulphonphthalein studies suggest that this is probably not due to a depression of glomerular activity but to a vasomotor failure to remove fluids from the body tissues.

Kidney function is more depressed with avertin than by the barbiturates.<sup>6</sup> This depression is transient and fully disappears in four to six hours.<sup>8</sup>

Regional anesthesia has no deleterious action on kidney structure or function. Regional anesthesia involving the sympathetic fibers to the kidney as in paravertebral block or spinal anesthesia is associated with an increase in urinary output.

**BLOOD:** A marked leucocytic reaction occurs after ether anesthesia. This reaction is much less marked after regional anesthesia.<sup>27</sup>

**BLOOD SUGAR:** The hyperglycemia associated with anesthesia has been variously interpreted as either the result of diminution in sugar metabolism or due to an increase in glycogenolysis, that is, an increase in the rate at which glycogen in the liver is converted into sugar and given off into the blood. Estes and Burge<sup>21</sup> conclude that this increase in blood sugar is due to a decrease in sugar metabolism.

Whatever this hyperglycemia is due to there is no doubt that an anesthetic agent which seriously interferes with carbohy-

blood sugar. If epinephrine is employed any change in blood sugar is the result of its action.

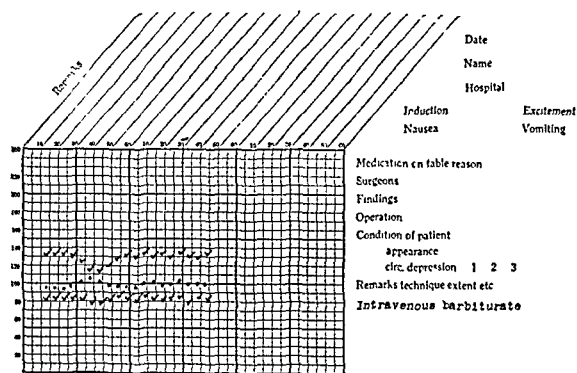


FIG. 5. Intravenous barbiturate medication.

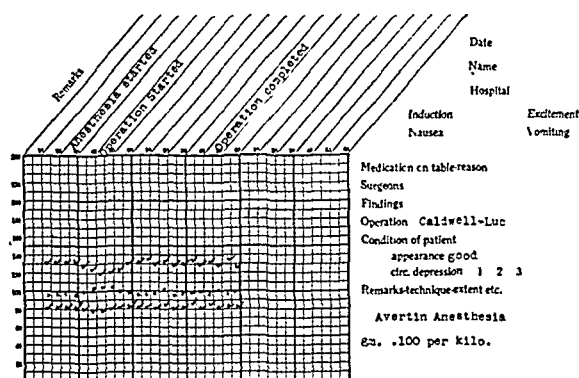


FIG. 6. Avertin (tribromethyl alcohol) anesthesia.

drate metabolism is contraindicated in several important pathological conditions associated with surgery.

There exists a close relationship between the rise in blood sugar and general anesthesia.<sup>79</sup> Ether perhaps is the greatest offender in this regard. The rise in blood sugar under ether anesthesia far exceeds that under regional or spinal anesthesia.<sup>79,93</sup> There exists, under ether, an average increase of 27 per cent six hours after operation and 18 per cent at the end of twenty-four hours.<sup>93</sup>

Nitrous oxide has no effect on sugar utilization.<sup>11</sup>

Ethylene anesthesia is associated with an increase in blood sugar.<sup>106</sup> This increase is variously reported as 45.3 per cent<sup>9</sup> immediately after anesthesia and by another<sup>109</sup> as 29 per cent above normal. The increase in blood sugar under ether anesthesia is reported as being 46 per cent greater than that under ethylene anesthesia.<sup>11</sup>

The barbiturates are also followed by a hyperglycemia.<sup>46,110</sup> The increase reaches a maximum in one to two hours and returns to normal in six to twenty hours.<sup>116</sup>

The hyperglycemia associated with avertin anesthesia is but very little above the normal limits.

The use of a solution of novocaine without epinephrine in field or peripheral nerve block is unassociated with changes in

Spinal anesthesia is associated with an increase in blood sugar considerably less than that which occurs under inhalation anesthesia. The increase under spinal anesthesia in a series of cases<sup>93</sup> amounted to 5.4 per cent at the end of six hours and 5 per cent at the end of twenty-four.

**BLOOD UREA:** An increase in blood urea is referable to accumulation due to defective elimination through the kidneys.<sup>108</sup> Agents which result in an increase in blood urea do so as the result of kidney irritation and would be contraindicated where this is to be feared.

Ether causes an increase in blood urea of 28 per cent six hours after operation. The increase continues and at the end of twenty-four hours mounts to 69 per cent.<sup>93</sup>

The gases are associated with an increase in blood urea. In the case of ethylene the increase begins immediately after operation and continues until at the end of twenty-four hours the increase amounts to 18.7 per cent over the preoperative normal.<sup>9</sup>

Derivatives of barbituric acid cause no change in the concentration of blood urea.<sup>30</sup>

Avertin, because of its mild kidney depression, is probably also followed by some degree of accumulation of blood urea though no available reports confirm or deny this. This accumulation must, of necessity, be small since the kidney irritation is but transient.

Spinal anesthesia produces no increase in blood urea at the end of six hours after operation. Twenty-four hours after operation the increase amounts to 24 per cent.<sup>93</sup>

**CARBON DIOXIDE COMBINING POWER:** The ability of the blood plasma to bind carbon dioxide offers what is probably the most reliable means of detecting acidosis and measuring its degree.<sup>108</sup> The value of an agent preventing acidosis is inversely proportional to the extent of change in the carbon dioxide combining power and the blood sugar produced.

Ether causes a decrease of 10 c.c. per 100 c.c. of blood plasma six hours post-operatively. Twenty-four hours postoperatively this decrease amounts to 3 c.c.<sup>93</sup>

Ethylene results in a moderate decrease in alkali reserve of the blood.<sup>9</sup> The same is true of nitrous oxide.

Barbituric acid derivatives are responsible for no change in the carbon dioxide combining power.<sup>12,122</sup> The same holds true for avertin. Bourne et al.<sup>6</sup> feel that neither amytal nor avertin affects the carbon dioxide combining power of the blood providing good color is maintained.

Neither novocaine nor agents allied to it have any marked action on the carbon dioxide combining power. In a series of cases operated upon under spinal anesthesia in which such studies were done<sup>93</sup> the carbon dioxide combining power decreased 7.8 c.c. at the end of six hours. At the end of the twenty-four hour period this decrease amounted to 3 c.c.

**MUSCULATURE:** Ether and chloroform in safe anesthetic dosage produce good relaxation of voluntary muscles. To obtain good relaxation for upper abdominal surgery under ether would be but to expose the patient to the harmful effects of deep ether anesthesia.<sup>100</sup>

Ether and chloroform, during surgical anesthesia, cause a marked loss of tonus amounting to almost complete inhibition of both rhythmic and peristaltic contractions in the stomach, small intestine and colon.<sup>81</sup> During the recovery period there occurs a return to normal.

Ethylene and nitrous oxide produce but slight relaxation of voluntary muscles. The relaxation produced by ethylene, how-

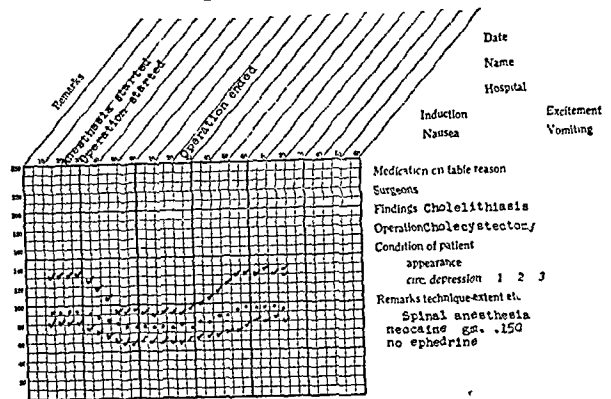


FIG. 7. Spinal anesthesia.

ever, is somewhat greater than that produced by nitrous oxide. Ethylene<sup>81</sup> produces usually no marked change in the muscular elements of the gastrointestinal tract. However, there sometimes occurs a slight increase in tonicity. Nitrous oxide<sup>81</sup> produces a marked increase in size of contraction of stomach, ileum and colon, probably due to anoxemia. On discontinuing the nitrous oxide there occurs promptly a very marked inhibition of activity in these three portions of the gastrointestinal tract.

All inhalation anesthetics possess an inhibitor action on uterine contractions in the following order, with chloroform the greatest offender: chloroform, ether, nitrous oxide, ethylene.<sup>91</sup>

The administration of a derivative of barbituric acid has no effect on uterine contraction nor does it alter its response to the "oxytoxic" principle of the pituitary gland.<sup>44,122</sup> Relaxation of voluntary muscle is fair and is proportional to the dose.

Avertin results in a degree of relaxation of voluntary muscles between that of the barbiturates and ether. It has no action on uterine contractions.<sup>88</sup>

The placing of a solution of novocaine about peripheral nerves results in but moderate relaxation. The action of novocaine on nerve roots within the subarachnoid space, as in spinal anesthesia, results in the most profound type of relaxation. Spinal anesthesia causes a paralysis

of the inhibitory sympathetic fibers to the gastrointestinal tract and allows the accelerative action of the vagi to pre-

washing out the rectum. Sodium amytal calls for the administration of a previously calculated dose. Pernocton, a quicker act-

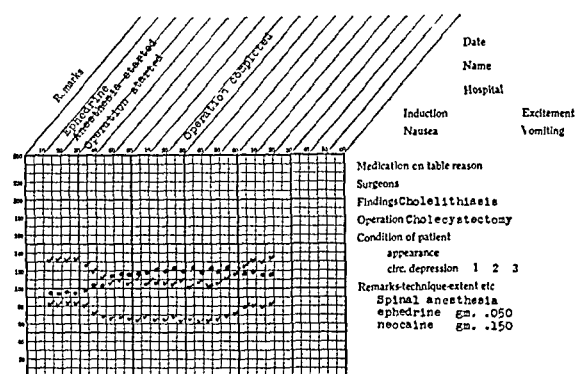


FIG. 8. Spinal anesthesia preceded by administration of ephedrine.

dominate, resulting in hyperperistalsis. It has no depressive action on uterine musculature.

**CENTRAL NERVOUS SYSTEM:** The inhalation anesthetics have no direct untoward action on the central nervous system. The administration of barbiturates in heavy doses and over a period of days may result in some degeneration of brain tissue. The barbiturates cause profound sleep but offer no protection against surgical shock to the nervous system.<sup>75</sup> Neither avertin nor the local anesthetic agents cause any damage to nerve structure. Regional anesthesia in all its forms offers the best known protection against surgical shock to the nervous system, because of the interruption of afferent stimuli that it produces.

#### CONTROLLABILITY

The large amount of gas-exchanging mucosa in the pulmonary system plus the ability to control respirations by the use of carbon dioxide-oxygen mixtures make the inhalation anesthetics subject to most exact control. Of the inhalation anesthetic agents ether is the least controllable since its action is not as rapid as that of nitrous-oxide or ethylene.

The use of avertin necessitates the use of a predetermined dose. Once given, any untoward symptoms cannot be relieved by

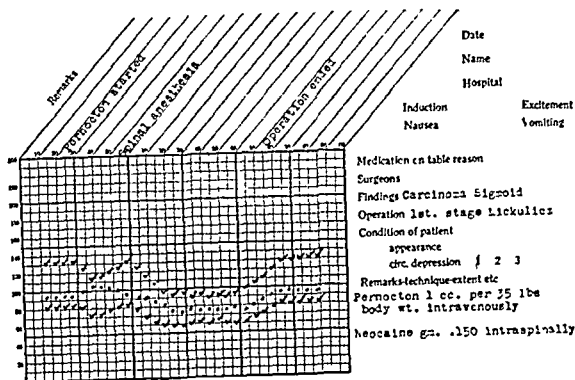


FIG. 9. Spinal anesthesia preceded by intravenous administration of barbiturate.

ing barbiturate, can be more readily controlled than sodium amytal, since, at the first sign of sleep, administration of the agent can be interrupted. Once administered the barbiturates cannot be removed. The effect of caffeine on narcosis from barbituric acid derivatives is antagonistic, tending to interrupt the sleep. The recovery time from barbiturates is markedly shortened by diuresis and the use of dextrose solutions intravenously.<sup>57,59,94</sup> The effects of spinal anesthesia last as long as the novocaine action is present on the nerves in the subarachnoid space. Once administered, the novocaine in the spinal canal can not be removed.

#### EXPLOSIVENESS

Of the anesthetic agents ether, ethylene, ethyl chloride, and acetylene are explosive. Acetylene is the most explosive. Because of this it has not been employed to any great extent anywhere other than in Germany. Mixtures of ether or ethylene with air or oxygen, in certain concentrations, are explosive. The number of ether air explosions are relatively small compared with the number of ether anesthetics administered.<sup>119</sup>

The administration of an explosive anesthetic through a gas machine increases the hazard in this direction. Electric

sparks resulting from the reestablishment of electrical equilibrium after charges have been accumulated on some insulated

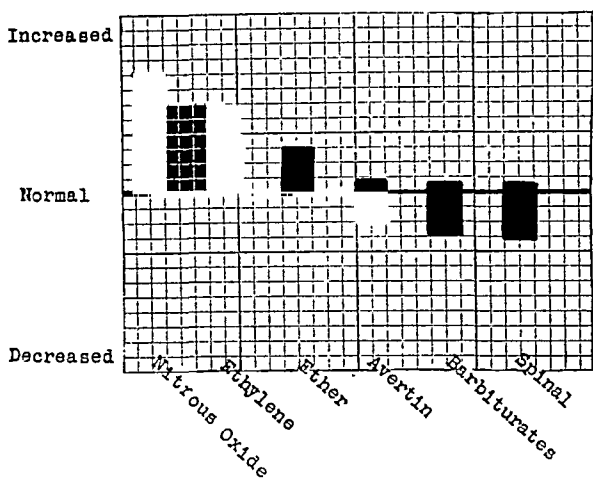


FIG. 10. Action of anesthetic agents on respiration.

part of the apparatus, usually as a result of friction, are the causes of explosions most important and most difficult to prevent.

The range of explosiveness of ethylene mixtures ranges from 4-22 per cent. That of ether extends from 2-50 per cent. The range of explosibility from ether is the greater of the two. Explosions occur more often with ether than with ethylene.<sup>43</sup> Statistics<sup>93a</sup> show an explosion in ethylene for every 42,000 cases. For ether the rate is 3 in 20,000 anesthetics.

Ethylene explosions are usually more violent and more fraught with danger than those occurring with ether. In spite of the danger of explosion with certain anesthetic agents the feeling exists that explosion is statistically the least of the hazards of anesthesia.<sup>43</sup>

#### LOCAL IRRITANT ACTION OF ANESTHETIC AGENTS

Ether is an irritant to the respiratory tract. It irritates and excites secretion from the glands lining the mucous membrane of the bronchial tree. It tends to produce postoperative pulmonary complications.<sup>101</sup> Neither nitrous oxide nor ethylene has any direct irritant action locally.

Of all the anesthetic agents avertin presents the greatest single danger as regards a locally irritant action. Avertin

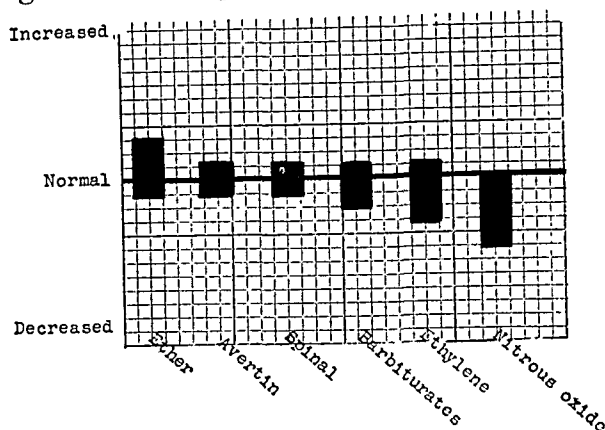
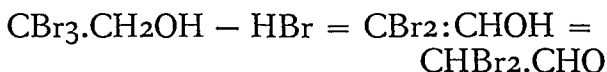


FIG. 11. Action of anesthetic agents on oxygen consumption.

fluid, as dispensed by the manufacturers, is a solution of tribromethyl-alcohol in amylene hydrate. The solution is very unstable. In preparing a 3½ per cent solution for anesthesia the avertin fluid is added to distilled water at a temperature between 35 and 40°C. Above 40°C. hydrobromic acid is split off and dibromacetaldehyde is produced according to the following chemical equation:



The presence of dibromacetaldehyde even in small amounts causes injury to intestinal mucosa. Severe sloughing may result. The obligatory test employing a 1:1000 congo red solution to determine the reaction of the solution will readily determine the presence of this highly irritating compound.

The solutions of barbituric acid derivatives for intravenous use are highly alkaline (pH 9.8) and hypertonic. It is important that these solutions be administered slowly so as to allow the buffer action of the blood to compensate for the differences in solutions.

Novocaine exerts no locally irritant action. The increase in popularity of regional anesthesia coupled with the desire for a longer acting local anesthetic agent



has resulted in the production of nupercaine (percain). The toxicity of nupercaine is high, even exceeding cocaine in this

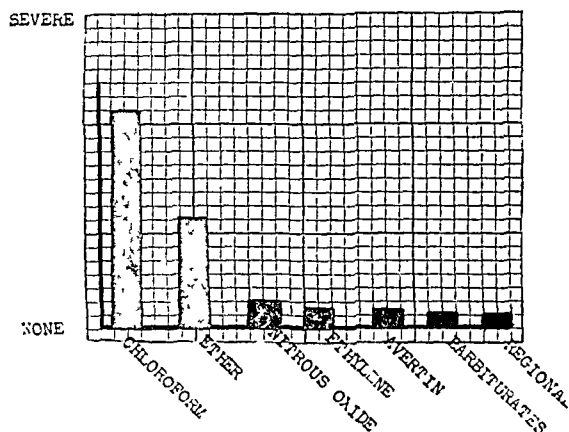


FIG. 12. Action of anesthetic agents on liver.

respect.<sup>29,67</sup> Solutions of this drug even in 1:2000 dilution cause an initial vascular relaxation in the vessels in the neighborhood of injection followed by a constriction.<sup>67</sup> This has frequently resulted in troublesome hyperemia and larger amounts of epinephrine in the solution are necessary than when employing novocaine.

Pantocaine, another new and long acting anesthetic for local anesthesia, is at present being used in Germany. Among the advantages claimed for it are its comparatively low toxicity and prolonged effect.

#### ANTAGONISTIC ACTION TO POISONING FROM LOCAL ANESTHETIC AGENTS

Death from novocaine or cocaine is the result of either an overdose, intravenous administration or an idiosyncrasy. A reaction is manifested by a convulsiform attack. This seizure is severe and if it involves the respiratory muscles may result in death.

Agents with ability to relax the voluntary muscles have been tried with the hope that relief of the seizure will follow. Tatum et al.<sup>107</sup> confirm the results of others that ether, morphine, chloral hydrate and atropine cannot be regarded as satisfactory antidotes for cocaine poisoning.

Hofvendahl<sup>47,48,49</sup> was the first to call attention to the protection which a derivative of barbituric acid affords an animal or

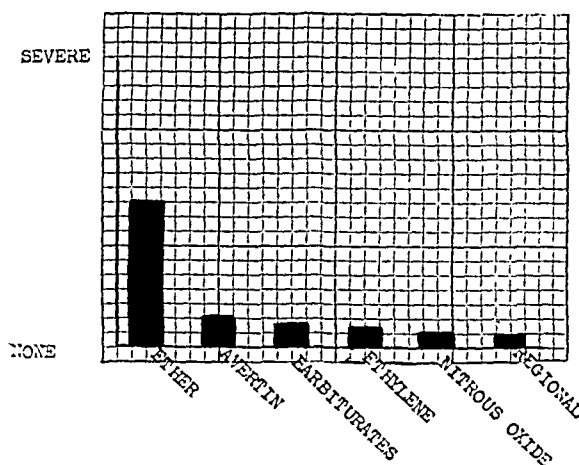


FIG. 13. Action of anesthetic agents on kidneys.

patient against the toxic effects of a local anesthetic agent. She demonstrated that an animal given what would ordinarily be a lethal dose of cocaine, would be prevented from death by subcutaneous administration of a derivative of barbituric acid. As a result of her work she recommends that a barbiturate be given to a patient suffering from acute cocaine poisoning.

Tatum<sup>106</sup> as did Mendola<sup>78</sup> showed also that the barbiturates act antagonistically to the convulsive effect of novocaine. This work has been repeatedly confirmed.<sup>38,62,73,74,85</sup> The antagonism of barbiturates for the local anesthetic agents is due to antispasmodic effect.<sup>52</sup>

#### THERAPEUTIC VALUE OF ANESTHETIC AGENTS

Ether because of its ability to relax musculature has been employed in many diseases marked by muscular spasm or rigidity. Notable among the diseases treated by this agent is whooping cough.<sup>83,105</sup> The value of ether in whooping cough is still not definitely decided.

The gases nitrous oxide and ethylene have found but small use in the field of therapeutics.

The barbiturates because of their antispasmodic action have not only found a

field of usefulness in the prevention and treatment of acute intoxication from local anesthetic agents but in other fields as

pectoris. The interruption of efferent sympathetic impulses is of great value in the treatment of circulatory diseases of the

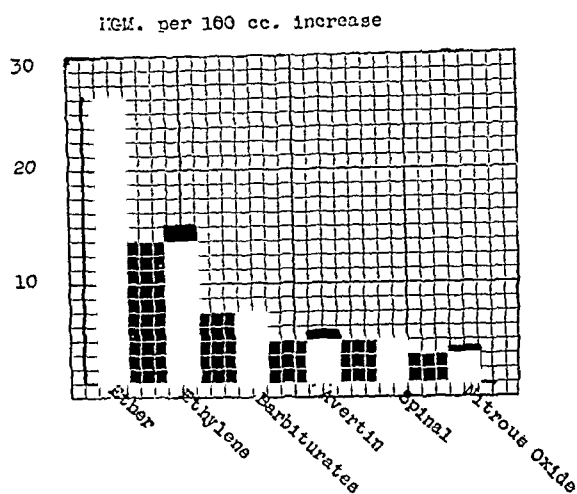


FIG. 14. Action of anesthetic agents on blood sugar.

well. Their value as antispasmodics is unquestioned in the treatment of convulsions from rabies, meningitis,<sup>69</sup> tetanus, strychnine poisoning, and eclampsia. Because of their hypnotic and sedative properties they have found a field of usefulness in the treatment of:<sup>2,32</sup>

1. Manic phase of manic depressive psychosis.
2. Catatonic schizophrenia.
3. Psychoneuroses.
4. Idiopathic epilepsy.
5. In cases attended by marked excitement with severe insomnia.

Avertin has been employed with satisfactory results in many of the conditions in which the barbiturates are of value. Among the many conditions treated by the former are tetanus,<sup>58,61,80</sup> phrenic exeresis,<sup>36</sup> chorea<sup>117</sup> and the excitement stages encountered in psychiatric diseases.<sup>4</sup>

The ability of the exploring needle to localize nerves carrying pain stimuli followed by the injection of a solution which will more or less permanently interfere with the passage of these stimuli has extended the value of regional anesthesia into the treatment of such conditions as trigeminal neuralgia, intercostal neuralgia, sciatica, tuberculous laryngitis and angina

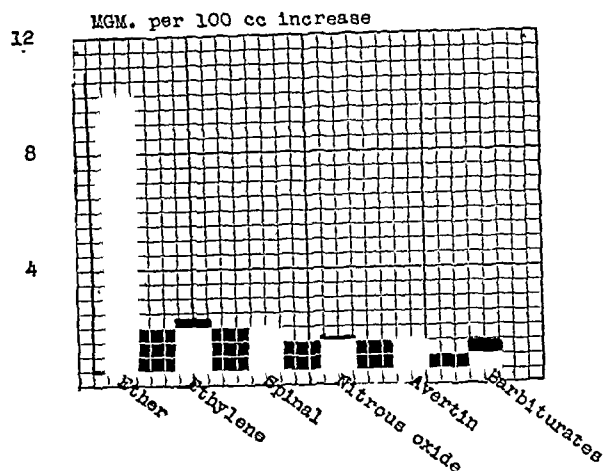


FIG. 15. Action of anesthetic agents on blood urea.

extremities as endarteritis obliterans, Raynaud's disease and trophic ulcers.

Spinal and splanchnic analgesia both occasion a marked hyperperistalsis. Thus they are of great value in the treatment of paralytic ileus. Spinal anesthesia is of value in the treatment of eclampsia.<sup>86,104</sup>

#### AGENTS

**CHLOROFORM:** Chloroform possesses severe toxic action on the liver, kidneys and heart. Since there are other anesthetic agents which possess all of its advantages and less of its dangerous qualities chloroform does not merit a place in modern anesthesia.

**ETHER:** Ether, today, is still the safest anesthetic agent in unskilled hands. It is readily controllable and produces good muscular relaxation. Its administration is associated with irritation to the pulmonary mucosa and tends to produce postoperative pulmonary complications. Its action on the blood sugar, carbohydrate metabolism and carbon dioxide combining power is marked. This, plus the loss of fluid co-existent with ether anesthesia, and the postoperative nausea and vomiting predisposes to acidosis. It depresses kidney and liver function and often produces tissue changes in these structures. Ether

is inflammable and has resulted in explosions in combinations with either air or oxygen.

Ether is contraindicated in all forms of

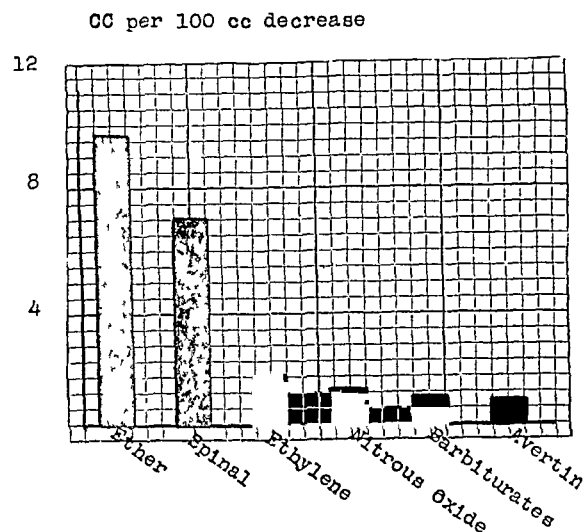


FIG. 16. Action of anesthetic agents on carbon dioxide combining power.

pulmonary disease. In vascular diseases, particularly when a sudden rise in blood pressure is to be feared, inhalation anesthesia is to be avoided, if possible. Ether is also contraindicated in diseases of the liver and kidneys. It should be avoided in diseases associated with deficient carbohydrate metabolism.

Ether is indicated in the absence of the above-mentioned diseases when a general anesthetic is desired and good relaxation needed.

**ETHYL CHLORIDE:** Ethyl chloride has a toxic action midway between that of chloroform and ether. It is a powerful anesthetic and is rapid in its action. It has but a limited field of usefulness in modern anesthesia. It is usually employed for short anesthetics where nitrous oxide or ethylene are not advisable or the apparatus not at hand.

**NITROUS OXIDE:** Nitrous oxide is comfortable to take. It is probably the most controllable anesthetic agent we have at this date. It exerts no toxic action on the body of itself. It is, however, associated with varying degrees of anoxemia which, in turn, may result harmfully. Nitrous

oxide causes a marked rise in blood pressure which contraindicates its use in arteriosclerosis with hypertension. It is

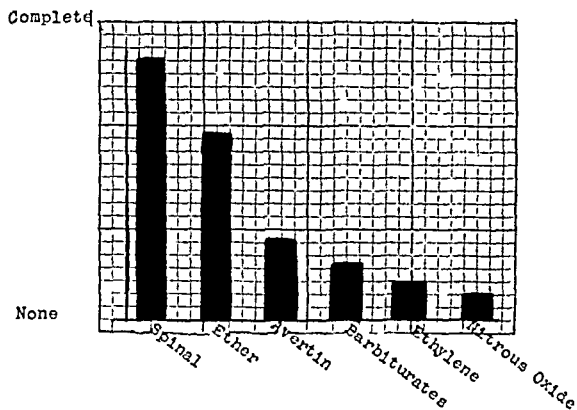


FIG. 17. Action of anesthetic agents on voluntary muscles.

non-inflammable and causes less nausea and vomiting than any of the other inhalation anesthetics. It does not produce good relaxation and is of value only in those conditions requiring general anesthesia with a minimum of relaxation.

**ETHYLENE:** Ethylene is the most dangerously explosive anesthetic agent at our command with acetylene probably the only exception. In spite of its extreme explosiveness it has caused less explosions than ether. It is not as comfortable to take as nitrous oxide. It stands next to regional and spinal anesthesia in freedom from toxic action. In this respect it has no pronounced advantage over nitrous oxide. Its main advantages over nitrous oxide are that it can be given with greater amounts of oxygen and produces a better degree of relaxation. Nausea and vomiting occur more frequently than after nitrous oxide. Ethylene should be administered only in the presence of adequate precautions to prevent explosion. It is of value when general anesthesia is desired and only moderate relaxation needed.

**BARBITURATES:** The barbituric acid derivatives are comfortable to take. They have no toxic action on the vital structures or functions. Their hypnotic action make them valuable as basal narcotics and

result in a great diminution in the amount of the secondary agent. These derivatives may be used as a preanesthetic agent with

Its action is not as prolonged and there is less possibility of postoperative pulmonary complications since the duration of sleep is

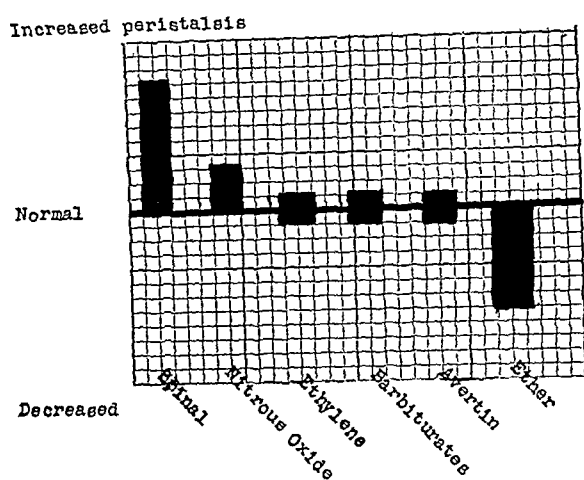


FIG. 18. Action of anesthetic agents on gastrointestinal musculature.

any of the general or regional methods. Their value in the prophylaxis and treatment of novocaine or cocaine poisoning makes them desirable in conjunction with regional or spinal anesthesia. Patients require less morphia and suffer less nausea and vomiting postoperatively. Their use as a preanesthetic agent is accompanied by a higher degree of vital reserve than when local or general anesthesia is used alone.<sup>54</sup>

In large doses there exists the possibility of pulmonary complications. Their action in the arteriosclerotic and hypertensive patient is often unsatisfactory. They are contraindicated in patients with unstable cardiovascular systems. The fall in blood pressure that they occasion makes them contraindicated in the presence of surgical shock. Their action is often followed by a period of excitement varying in length and intensity depending on the derivative used.

Of the two most popularly used barbiturates, pernocton impresses the author as being the more valuable in the majority of cases. Pernocton is a more stable solution and has twice the strength of sodium amytal.<sup>77</sup> It is relatively less toxic than the other barbiturates since it undergoes a more rapid decomposition in the body.<sup>25</sup>

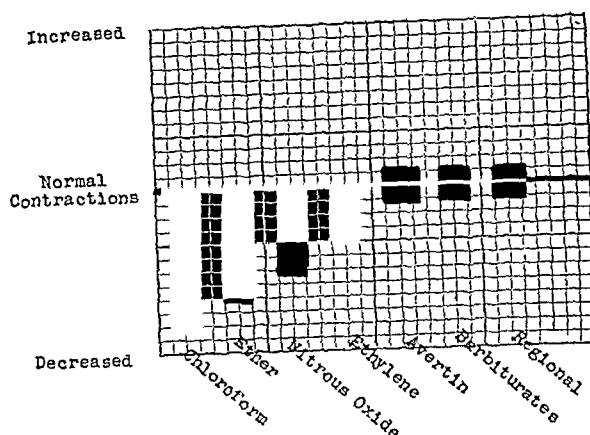


FIG. 19. Action of anesthetic agents on uterine musculature.

comparatively short. There occurs less excitement, laryngospasm and cyanosis associated with its use than is true of the other barbiturates.

There are many water soluble barbiturates recommended for intravenous medication. One cannot assume that the actions of closely related barbituric acid derivatives are identical but it is safe to conclude that they are analogous and comparable to a degree.<sup>54</sup>

**AVERTIN:** Of all the anesthetic agents, avertin produces the most pleasant and calm induction. Distress, nausea and vomiting are absent in the recovery period. There exists no stage of excitement as occurs in the use of barbituric acid derivatives. The period of amnesia is prolonged. The extent of respiratory depression is not as marked as with the barbiturates. As a basal narcotic it results in the lessening of the secondary anesthetic agent. Nitrous oxide can be administered with large amounts of oxygen and a fair grade of relaxation obtained. Its use is followed by no pulmonary or cardiac complications attributable to the agent.

Its greatest value is in prolonged operations about the head and neck. Particularly is this true when electrosurgery is employed. The author employing a method

of fractional administration, soon to be reported, finds it very seldom necessary to administer a secondary anesthetic in using

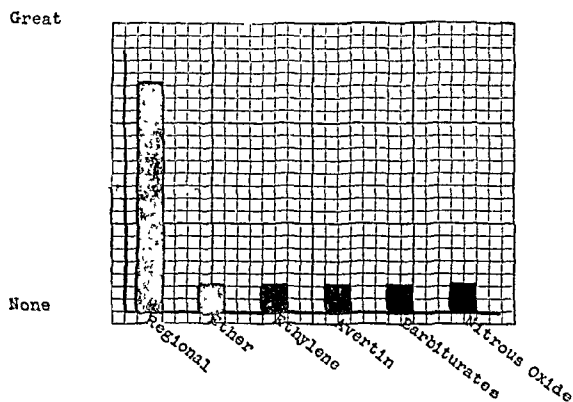


FIG. 20. Extent of protection offered central nervous system against surgical shock.

avertin for head surgery in dosage not exceeding gm. 0.12 per kilogram of body weight.

The relaxation produced exceeds that of the barbiturates. It is of value in conjunction with all other anesthetic agents as a basal narcotic. It is indicated in cases of respiratory and renal disease when ether is employed to lessen the tissue irritation of the latter. Sise<sup>98</sup> feels it of great value in long orthopedic operations. It has been employed with great satisfaction in thyroidectomy, thoracic operations, sinus surgery and obstetrics. Its value in the treatment of eclampsia, tetanus and excitement stages of mental diseases is great. The relative merits between avertin and the barbiturates in this latter field have never been decided. The author leans towards the barbiturates feeling that they are probably of greater value as therapeutic agents.

Avertin possesses two great disadvantages:

1. As a result of its unstable character, improper preparation of the solution may result in great damage to the rectal mucosa.
2. Because of its rapid absorption the patient may be flooded with a toxic dose that cannot be withdrawn if the dosage is not carefully calibrated.

Avertin is contraindicated in diseases of the rectum and colon. In patients suffering from advanced renal or liver disease this agent should not be employed.

**REGIONAL ANESTHESIA:** Of all the anesthetic procedures, regional anesthesia offers the greatest protection to the central nervous system against surgical shock. Of the anesthetic agents, novocaine is considered the most safe and satisfactory in regard to toxic action on the body structures and functions. There exists but small chance of pulmonary, cardiac, liver or renal complications following its use. The relaxation obtained by peripheral nerve block is not as satisfactory as may be obtained by other methods.

In the field of therapeutics it is a valuable adjunct. The action of paracervical block in slowing the heart<sup>7</sup> makes the procedure valuable in operations on the toxic thyroid gland. Slowing cardiac action diminishes the occurrence and severity of thyroid crises.

The great danger always present in the administration of a local anesthetic agent is the acute intoxication which may occur as result of overdose, intravenous injection of the agent or idiosyncrasy. If a barbituric acid derivative is administered before the local procedure is begun this danger is considerably minimized. There exists the feeling among some anesthetists that large doses of barbiturates interfere with the efficiency of local anesthetic agents because of their antagonism.

**SPINAL ANESTHESIA:** The introduction of novocaine in the subarachnoid space is followed by:

1. Sensory anesthesia
2. Motor paralysis
3. Fall in blood pressure
4. Decrease in respiratory rate and volume
5. Decrease in cardiac rate
6. Hyperperistalsis.

**Sensory Anesthesia.** The sensory anesthesia produced is absolute with the exception that complete loss of tactile sensation does not always occur. Many patients

object to the sensation produced by manipulation and interpret it as pain. This is a distinct disadvantage associated with

The action of adrenalin as a vasoconstricting agent is not of much value since its action is very short. Ephedrine is not

COMPOSITE CHART

	FULL ORAL INTIMATION	LIVER	KIDNEY INTIMATION	END OF SUGAR	BLOOD UREA	CARDIO DILATOR	COUGHING POWER	REL. VIT. OF	REL. VIT. OF	PHOSPHORUS	UTERINE CONTR. ACTIONS	PROTECTION TO C.N.S.	LOCAL ANESTH. ACTION	HYPEROSTIC ACTION TO	LOSS OF CONSCIOUSNESS
CHLOROFORM	+++	+++	+++	+++	+++	---	++	---	---	---	0	++	0	+	
ETHER	+++	+++	+++	+++	+++	---	++	---	---	---	0	+++	0	+	
NITROUS OXIDE	+	++	0	0	+	--	+	++	--	0	+	0	+		
ETHYLENE	+	+	0	++	++	--	++	+	-	0	+	0	+		
BARBITURATES	0	0	+	++	+	-	++	0	0	0	+	+++	+		
ANESTHETIC	0	+	+	+	+	-	++	0	0	0	+++	0	+		
COGIC AL	0	0	0	0	0	0	+	0	0	+++	0	0	0		
SPI AL	0	0	0	+	+	-	+++	+++	0	+++	0	0	0		

\*Only if improperly prepared.

FIG. 21. Composite chart.

spinal anesthesia. It may be easily overcome by sufficient preoperative medication.

**Motor Paralysis.** The relaxation that takes place far exceeds that under any other form of anesthesia. This great extent of relaxation facilitates operative procedures, particularly those in the upper abdomen, and results in a decrease in operating time. Difficult procedures can be carried out with less use of deep retraction and walling off pads, thus diminishing operative trauma.

**Fall in Blood Pressure.** The fall in blood pressure that occurs is proportional, to a degree, to the height of anesthesia obtained. This fall in blood pressure is the result of paralysis of the vasoconstrictor fibers to the splanchnic blood vessels. The fall in blood pressure is the greatest danger associated with spinal anesthesia. A severe fall in blood pressure may cause cerebral anemia and death may result. There are two methods employed to prevent this upward reaction:

1. Maintaining the blood pressure by vasoconstricting drugs such as adrenalin or ephedrine.
2. Preventing cerebral anemia by an adequate Trendelenburg position.

primarily a vasoconstricting agent but raises the blood pressure through its cardiac stimulation.<sup>93</sup> Because of its cardiac acceleration its use is associated with an element of danger.<sup>93</sup>

The use of the Trendelenburg position is sufficient in itself to prevent anemia of the brain and should be employed in all cases of spinal anesthesia. The use of a viscous solution of novocaine of lighter specific gravity than spinal fluid has no definite advantages over a simple novocaine solution. Novocaine in glucose makes a solution heavier in specific gravity than spinal fluid and, as a result, calls for the employment of some degree of Fowler's position. Since the safest and most certain way to prevent cerebral anemia is by the use of the Trendelenburg position, any technique that calls for the use of any other position of the patient should not be employed.

**Decrease in Respiratory Rate and Volume.** Novocaine intraspinal causes paralysis of the accelerator fibers to the respiratory musculature and a decrease in respiratory rate and volume follows. This decrease is often associated with some degree of pallor

but never cyanosis. Respiration responds readily to carbon-dioxide oxygen mixtures. The feeling that spinal anesthesia may

back away from the wound rather than poke up into it as is true with inhalation anesthesia. This hyperperistalsis makes spinal

Diseases Which Contraindicate Certain Anesthetic Agents	Chloroform	Ether	Nitrous Oxide	Ethylene	Barbiturates	Avertin	Regional	Spinal
Heart disease								
Compensated.....	+++	—	—	—	—	—	—	—
Non-compensated.....	++++	++	++	+	—	—	—	—
Hypertension.....	+++	++	+++	++	—	—	—	—
Hypotension.....	+++	++	+	+	+	+	—	+
Kidney disease.....	++++	++++	—	—	+	+	—	—
Liver disease.....	++++	++++	—	—	—	+	—	—
Hyperthyroid.....	++++	++	+	—	—	—	—	—
Diabetes.....	++++	+++	—	—	—	—	—	—
Resp. obstruction.....	++++	++++	+++	++	—	—	—	—
Shock								
Untreated.....	++++	++++	+	+	++	+	—	+
Treated.....	+++	++	—	—	—	—	—	—
Intestinal obstr.								
Curative operation.....	+++	++	+	+	—	—	—	—
Palliative operation.....	++++	+++	+	+	—	—	—	—
Pulmonary dis.....	++++	++++	++	++	+	+	—	—

Indicated —

Contraindicated +

sufficiently depress respiration as to cause death has been thoroughly disproved by the excellent work of Koster and Kasman.<sup>64</sup>

**Decrease in Cardiac Rate.** The introduction of novocaine in the subarachnoid space results in paralysis of the accelerator sympathetic fibers to the heart and allows the depressor action of the vagus to predominate. This slow heart action is never the cause of untoward reactions and may be interpreted as a desirable symptom.<sup>93</sup>

**Hyperperistalsis.** The hyperperistalsis that occurs is the result of paralysis of the depressor fibers to the intestines. This hyperperistalsis is associated with a narrowing in the lumen of the gut. This narrowing in the lumen of the gut facilitates surgical procedures as the intestines fall

anesthesia a valuable agent in cases of acute intestinal obstruction providing intestinal drainage is instituted.

The operative time in spinal anesthesia is limited usually to one hour although it sometimes extends to one and one-half hours. The administration of an inhalation anesthetic to a patient already under spinal anesthesia should be slow and careful. Nausea and vomiting sometimes occur during spinal anesthesia particularly during manipulation in the upper abdomen. Many patients object to being conscious during spinal anesthesia. The combination of intravenous administration of a barbituric acid derivative and spinal anesthesia is sometimes employed. Care must be taken to allow the fall in blood pressure that

occurs with barbiturate medication to return near normal before subjecting the patient to the fall in pressure that is so intimately associated with spinal anesthesia. The interval necessary is usually about twenty minutes (Fig. 9). The use of spinal anesthesia in patients with renal deficiency is valuable since spinal anesthesia is responsible for an increase in urine output.

**OTHER AGENTS: Acetylene.** Acetylene is an extremely explosive gas. It is used to some extent on the continent but as yet has made no marked appearance in this country.

**Propylene.** Propylene has a direct irritant action on heart muscle. It causes marked irregularities in cardiac action and therefore should not be used as an anesthetic agent.

**Ethyl Alcohol.** The use of alcohol in a glucose solution has been employed as an anesthetic agent with varying results. It is administered intravenously. Sufficient laboratory data on this agent are not available and not much work has been performed in this direction.

**Cyclopropane.** This gas is explosive in combination with small percentages of air

or oxygen. The inability to manufacture constantly pure specimens has limited the use of this agent.

**Chloral Hydrate.** Chloral hydrate as an anesthetic agent to be given by rectum has been used in but a very limited number of cases and no laboratory studies have been made.

#### CONCLUSION

If a non-toxic, non-irritating, easily administered, safe, controllable agent constitutes the ideal anesthetic then we have today no agent which we could thus classify. Each anesthetic agent at our command has one or two unsatisfactory characteristics. The choice of the best anesthetic agent depends upon a knowledge of the action of the various anesthetics, a thorough understanding of the pathological processes present in the patient and the character of the operation proposed. The final choice of the agent or combination of agents should be those that would expose the patient to the least amount of harm and give him the greatest chance of getting well.

#### REFERENCES

1. ALKE, A. Pernoxon-ether anesthesia. *Deutsch. Med. Wchnschr.*, 1: 227-228, 1928. *Abst.: Schmerz*, 1: 257, 1928.
2. BLECKWENN, W. J. Narcosis as therapy in neuropsychiatric conditions. *J. A. M. A.*, 95: 1168, 1930.
3. BLOOMFIELD and SHIPWAY. The use of avertin for anesthesia. *Lancet*, 1: 546, 1929.
4. BLUME, G. Use of avertin in psychiatry. *Deutsche Med. Wchnschr.*, 53: 1307, 1927.
5. BOSSE, P. Intravenous pernoctone anesthesia. *Deutsch. med. Wchnschr.*, 1: 272-273, 1928.
6. BOURNE, W., BROGER, M., and DREYER, H. D. The effects of amytal and avertin, separately, on the blood. *Anesth. & Analg.*, 10: 85-87, 1931.
7. BROWN, A. The influence of cervical paravertebral anesthesia upon the pulse rate during operation in the toxic thyroid gland. *Surg. Gynec. Obst.*, 52: 25, 1931.
8. BRUGER, M., BOURNE, W. and DREYER, N. B. Avertin and liver function. *Am. J. Surg.*, 9: 82, 1930.
9. BRUMBAUGH, J. D. Effect of ethylene oxygen-anesthesia in the normal human being. *J. A. M. A.*, 91: 462, 1928.
10. BUMM, R. Anesthetic experiments with intravenous administration of barbituric acid derivatives. *Deutsch. Ztschr. f. Chir.*, 202, 289-303, 1927. *Abst.: Narkose u. Anaesth.*, 1: 158-159, 1928.
11. BURGE, W. E., and VERDA D. J. Stimulating effect of alcohol and depressing effect on sugar utilization directly determined. *J. Pharmacol. & Exper. Therap.*, 34: 299, 1928.
12. DEUEL, H. J., CHAMBERS, W. H., and EVENGREN: J. Effect of insulin on metabolism of dogs under amytal anesthesia. *Proc. Soc. Exper. Biol. & Med.*, 22: 424-425, 1925.
13. DRABKIN, D. L., RARDIN, I. S., and LAPHAM, M. E. *Am. J. M. Sc.*, 178: 379, 1929.
14. DUROEULX, J. Somnifencina anesthesia of laboratory animals. *Rev. med. de L'est*, 54: 277, 1926. *Abst.: Physiol. Abstr.*, 11: 384, 1926-1927.
15. Editorial: Barbitol and related hypnotics. *J. A. M. A.*, 91: 398-399, 1928.
16. Editorial: Intravenous anesthesia. *Minnesota Med.*, 12: 794-795, 1929.
17. Editorial: Sodium amytal. *Indianapolis M. J.*, 32: 203, 1929.
18. ELLIS, M. M. Barbitol narcosis and hypothermia in pigeons. *J. Pharmacol. & Exper. Therap.*, 21: 323-342, 1923.

[References continued on p. 508.]



# EXPERIENCE WITH LUMBAR ANESTHESIA IN OBSTETRICS\*

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ANESTHESIA, until less than fifty years ago, depended on the use of cerebral intoxicants; alcohol, mandragora and opium in ancient times, ether, chloroform, nitrous oxide and a variety of other volatile agents used by inhalation and by rectum since the middle of the nineteenth century. Only since the discovery of agents capable of application to peripheral neurons has the necessity of deadening the brain to obtain relief of pain been avoidable.

The application of anesthesia to patients in labor began shortly after the use of inhalation anesthesia in surgery, but has not kept step with it. The necessity for surgery is pathological; labor is physiological; the pain of surgery is calamity; that of parturition is normal life-experience. Not only do medical and popular imagination not respond so readily to the need for obstetric anesthesia, but tradition and even theological authority have repeatedly been strongly arrayed against its development. Even today, while surgical patients universally demand anesthesia for the most trivial operations, thousands of women endure the pain of childbirth, often of excruciating intensity, without any anesthetic relief.

Moreover, the problems concerned with obstetric anesthesia differ sharply from those of other types of surgery. There is general parallelism in the facts that obstetric operations are frequently indicated by conditions just as seriously pathological as those for which general surgical procedures are undertaken; that obstetric patients sometimes are poor physical risks by reason of toxemia and other intercurrent conditions which contribute to the hazards of general surgery; and that shock and hemorrhage are alike a

jeopardy in both classes of work. But there is very significant divergence between general surgery and obstetrics, in the difference in length of anesthesia required, and in the fact that obstetrics nearly always involves two patients in one, as general surgery does only in the extremely rare instances of its application to joined monsters.

Labor involves many hours, stretching sometimes into days, whereas the most formidable and tedious operations of general surgery can hardly last more than three or four hours. Before efficient anesthesia was obtainable, surgeons shortened the time of their work by the cultivation of a deft speed which probably has no modern counterpart. And today, while speed per se is not a primary desideratum, a reasonable acceleration of delicately precise technique does much to obviate postoperative morbidity. No comparable means of shortening the time required for the normal, or safe operative evolution of parturition is at the disposal of the obstetrician.

Hence, while general surgery demands total anesthesia for its activities, the obstetrician must accept for his patients a partial relief only for the pangs of delivery.

The necessity for this acceptance of partial analgesia instead of full anesthesia depends on the deleterious effects on the woman's own vital processes of inordinately prolonged administration of intoxicating anesthetics and the even more direct and serious menace thereof to the survival and health of her child. Long since, therefore, the employment of anesthesia in obstetrics has determined itself into two phases; the use of analgesic agents or combinations for the relatively less severe suffering of the first stage and the early part of the second,

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and the supplementary employment of true anesthetics for the termination of the second stage, especially if that termination is operative.

Even used in this fashion, however, anesthetics depending on cerebral action involve in considerable degree the hazards previously pointed out, especially to the baby, so that anesthetic methods depending on regional rather than central action present an especial appeal to the obstetrician.

In my own case, this appeal focussed on the possibilities of lumbar anesthesia in the summer of 1926. Local infiltration had been somewhat used in selected cases for several years, but was most difficult to use in the cases in which we most desired to keep away from inhalation anesthesia, namely, highly toxic patients who by reason of irrational excitation were incapable of the degree of cooperation necessary for success. Caudal anesthesia was later tried, but was less regularly successful, was somewhat more difficult technically, was sometimes too circumscribed in its effect, and was occasionally attended with troublesome psychic disturbance. Parasacral and paralumbar injection appeared to entail a difficult and elaborate technique which did not encourage personal trial.

The American literature at that time recorded general surgical experience with spinal anesthesia, thousands of cases, and many of these had been pregnant women; a few obstetricians had used spinal anesthesia in laparotomies, where they had merely applied surgical experience; only one obstetric clinic, in Los Angeles, was developing this method systematically;<sup>1</sup> the majority of American obstetricians were without any experience whatever; a few had a limited experience but were afraid and distrustful of it.

Surgeons of the greatest experience were insistent on its definite and serious dangers. Babcock<sup>2</sup> stressed the importance of an ever-ready "rescuesquad"; moreover, there was and still is, some feeling that pregnant women are especially poor risks for spinal

anesthesia. Therefore, our first necessity was to ascertain and demonstrate the *safety* of the method.

The factors upon which we conceived such safety to depend were:

1. Selection of least toxic agent
2. Restriction of dosage
3. Low injection
4. Careful observation of patient and recording of data on each case
5. The utilization of measures to combat fall of blood pressure, urged as the invariable, and one of the great dangers.

At the same time we tried to adopt such refinement of details of technique as would induce maximum efficiency, and minimize trauma and disagreeable sequelae.

Important in this regard are:

6. Choice of size and type of needle
7. Posture for injection
8. Dilution of the anesthetic
9. Amount of barbotage
10. After-treatment.

1. Novocaine was selected as the least toxic agent available. Neocaine has been used alternatively, but except for slightly greater solubility, has not appeared superior in clinical results. A limited use of spinocaine was later made for comparative purposes, but this agent was abandoned. It introduces several foreign substances into the arachnoid sac, which is undesirable except to obtain very definite advantages. These advantages did not appear. Its much vaunted "controllability" of area of effect seemed to us, in carefully controlled comparison with novocaine, mythical. It is less flexible than novocaine in that the posture of the patient is restricted, as it is not with novocaine. Recently, 50 cases were subjected to lumbar anesthesia with nupercaine, but the use of this agent has been abandoned because anesthesia was slower and less certain than with novocaine, nausea, vomiting and headache were of more frequent occurrence, and the headache was of more severe type. This experience has already been reported in detail elsewhere.<sup>3</sup>

2. We began with doses as small as 25 mg., gradually increasing under careful observation of reaction, to doses which we have found adequate for our work. Vaginal and perineal operations are done under a standard dose of 50 mg.; laparotomies, one of 100 mg.; the latter dose is sometimes increased to 150 mg.; there is no fixed indication for this increase, but we feel a little more sure of adequate anesthesia with the larger dose.

3. For vaginal and perineal work the best level for injection is the fourth lumbar interspace; for obstetric laparotomies, the third. It may be noted that we do not employ the "high" classical cesarean section; all our laparotomies are made below the umbilicus, whatever type of uterine incision is made.

4. In the beginning we devised a special form for charting observations, and one attendant's exclusive duty is to watch the patient closely and to chart his observations continuously. In addition to the increased safety of the patient, this relieves the operator of anxiety, and permits the recording of valuable data.

5. Blood pressure variations were at first of much concern to us and in the beginning there was much flurried use of many agents to overcome what seemed like dangerous falls. Especially in originally hypertensive cases are the blood pressure excursions dramatic. We early learned the futility of our panic, and for a long time have employed only two means of offsetting blood-pressure variation and its effect on the economy, namely, the use of 50 mg. ephedrine hypodermatically before the lumbar injection, and the use of the Trendelenburg posture. If the dose of novocaine does not exceed 50 mg. no postural treatment is necessary, but when larger doses are used the Trendelenburg position is utilized, for I believe thoroughly that such posture is essential and is all that is essential to overcome the effect of blood pressure fall.

As to the utility of ephedrine, I know of the storm of controversy that is at present

raging about it, and have no especial desire to participate in it. It seems to me *a priori* desirable to maintain a physiologic status if possible, especially as every obstetric patient is potentially subject to hemorrhagic shock. Whether we concede the identity of such shock, and the blood-pressure depression of spinal anesthesia or not, it would appear undesirable to have one superadded to the other. In our observation ephedrine does appear to maintain the status *quo ante* in relation to blood-pressure level, in a degree warranting its continued use. In the first consecutive 50 cases (50 mg. novocaine) without ephedrine the mean fall in blood pressure was 26 mm. Hg systolic, 17 mm. Hg diastolic. In a similar consecutive number of cases, using ephedrine, the mean fall in blood pressure was 5.7 mm. Hg systolic, 5.3 mm. Hg diastolic.

We seldom omit ephedrine even in hypertensive cases; it sometimes does cause a slight rise of blood pressure; as we have before pointed out, however, hypertensive cases exhibit the greatest drop in pressure, roughly proportional to the degree of original hypertension; it is just these cases therefore which most need the stabilizing effect of ephedrine.

6. We like a needle of 22 to 20 gauge. We are not convinced that the size has much to do with postoperative incidence of headache, but prefer to use small calibered needles for the sake of a non-traumatizing technique in respect to *all* the tissues traversed. Various types have been tried. The conical pointed needle is beautifully atraumatic, but gives little differential tactile sensation as the various tissue levels are successively penetrated; if bone is impinged upon, the end of the stylet is spread away from the point of the needle itself, resulting in a dangerously tissue-rending prong. The very short beveled needle of Pitkin is too blunt to penetrate the more resistant tissues readily, requiring a pressure which may readily divert it from its true course. In experiments with excised meningeal tissue stretched against moderate liquid pressure we were unable to

demonstrate the alleged "trap-door" opening made by this needle, or any significant difference in leakage through the punctures made by this and other types of needle. We prefer a sharp moderately beveled needle, of which type that of Labat is a good example.

7. Novocaine permits safe administration in either the erect or lateral-prone posture, which is not true of spinocaine. The former is sometimes easier for the anesthetist, but for most obstetric patients the lateral-prone posture is somewhat more comfortable, and entails less handling of the patient, so that we use this posture in nearly all our cases.

8. Small amounts only of spinal fluid are necessary to dissolve and dilute the novocaine. Two and one half cubic centimeters for a 50 mg. dose, to 4 c.c. for a 100 mg. dose, have proved to be satisfactory proportions.

9. The amount of barbotage is also proportional to the dose employed, and the extent of anesthesia desired. In smaller dosages (50 mg.) barbotage results in such dilution of the anesthetic agent that the neurons which it reaches are incompletely anesthetized. When 100 to 150 mg. to a dose is used, barbotage distributes it sufficiently concentrated to a series of neurons numerous enough to obtain anesthesia over an area adequate for our work.

10. The after-treatment is simple. Patients, if they have been in Trendelenburg position on the table, are transported back to bed in this position, and all patients are maintained so for six hours after anesthesia. This permits the blood-pressure level to be gradually stabilized without risk of cerebral anemia, acts as a prophylactic against postpartum hemorrhage, and reduces the shock of any blood loss the delivery may have entailed.

Liquids are permitted during the anesthesia and immediately afterward, and unless there is surgical contraindication, solid food is given at the next regular mealtime.

If headache is complained of, ice applications locally, with moderate doses of

salicylic-acid or barbituric-acid compounds suffice for its relief, the patient being kept flat or in slightly inverted posture.

To April 1, 1931 we have given 1832 lumbar anesthetics in 8683 deliveries (21.09 per cent). There has been no maternal or fetal mortality attributable to this method of anesthesia. Failure of anesthesia has been less than 2 per cent. Abnormal reactions during the anesthesia, besides the blood-pressure variations, which have been discussed, have been in all 0.37 per cent of cases, as follows:

Circulatory disturbance indicated by cyanosis	
and weak rapid pulse, transient.....	1 case
Severe headache.....	3 cases
Numbness of upper extremities.....	1 case
Vomiting.....	20 cases
Difficulty in breathing, few minutes only.....	1 case
Marked nervousness and anxiety.....	6 cases

Postanesthetic sequelae have included the following: Headache, 18 per cent; of these 20 per cent, or 3.6 per cent of the whole, have been severe for a few days; 2 cases only, 0.02 per cent of the whole, lasted four and twelve weeks respectively; one case of mild paresthesia of the thigh lasted eight weeks, and one of the calf and heel, two weeks.

The action of spinal anesthesia on the course of labor is to retard it. Thus, if given electively near the end of the second stage of cases presumably capable of spontaneous delivery, two-thirds of them will be arrested, and will require artificial aid. They will deliver normally, however, if time be given to allow the wearing off of the anesthesia.

This effect does not depend on abolition of the uterine contractions; the presenting part may be seen advancing and receding during this period of arrest, in response to rhythmic uterine contractions, of approximately the same periodicity and duration as before the administration of the anesthetic. Uterine relaxation and bleeding during the third stage and post partum is not increased. Under direct vision in cesarean section the contractibility of the uterus is prompt and vigorous. The action of oxytoxics on the uterus is not impaired.

A limited series of pressure observations, with a specially constructed manometer attached to a hydrostatic bag placed within the uterus, indicated no essential change in the power of the contractions.

The retarding action on labor would appear to depend, therefore, on the loss of the auxiliary powers, partly due, no doubt, to slight depression of the voluntary motor power of the muscles, but mostly dependent on the abolition of the sensory phase of the sensory-motor reflex which normally brings these forces into play. This confirms De Lee's statement: "After dilatation of the cervix the abdominal muscles alone are able to expel the child, and usually do it, since the uterus by this time, . . . has very little expulsive power."<sup>4</sup>

Spinal anesthesia produces good relaxation of the soft parts but not as much as deep surgical narcosis with chloroform. It is sufficient, for instance, to facilitate podalic version employed under proper conditions. Statements that it causes magical disappearance of resistance in undilated cervixes, and entire avoidance of potentiality of perineal laceration have not been borne out in our observation, and we believe they are misleading and dangerous.

The effect of spinal anesthesia on the fetus is nil. In no single case has apnea been observed not dependent on causes other than the anesthesia. Moreover, repeated observation has shown that morphine administered to the mother in average therapeutic dose during the first or second stage, regardless of the interval until the birth of the child, does not cause fetal asphyxia; we therefore regard the apnoea attributed to morphine in causing fetal apnea, to be more justly ascribable to the combined effort of that drug and general anesthetics. Williamson<sup>5</sup> has recently made the same observation relative to

infiltration anesthesia for the termination of the second stage of labor.

Lumbar anesthesia is not a method for first-stage, or for prolonged second-stage, analgesia, by reason of its short duration. It is therefore not an alternative for opiates, synergistic analgesia, pernocton, avertin, or inhalation agents used for this purpose.

It does, however, offer the obstetrician a means of absolute anesthesia, non-toxic, and not otherwise dangerous to mother or baby. It does not increase the danger of hemorrhage. The absolute quiescence of the patient assists in the maintenance of aseptic technique, and the facility of abdominal operative procedures, and minimizes the postoperative morbidity of the latter. The absence of toxicity is especially significant in a large group of patients handicapped by pulmonary, thyroid, heart, hepatic and renal disease.

These advantages it shares with all types of local or conductive anesthesia, but excels all other types in simplicity and effectiveness.

It is applicable to the termination of the second stage of labor in:

1. Normal cases in which analgesia requires to be supplemented by true anesthesia, provided the obstetrician is prepared to accept a largely increased necessity for elective artificial delivery.

2. All cases initially requiring operative delivery, by either the vaginal or abdominal routes.

#### REFERENCES

1. MARTIN and ARBUTHNOT. *J. A. M. A.*, 87: 1723, 1926.
2. BABCOCK, W. W., *J. A. M. A.*, 87: 1729, 1926.
3. COSGROVE, S. A. Nupercain subdurally in obstetrics, *Am. J. Obst. & Gynec.*, 22: 763, 1931.
4. DE LEE, J. B. *Principles and Practice of Obstetrics*. Ed. 5. Phila., Saunders, 157, 1928.
5. WILLIAMSON, H. C. Caesarean section under local anesthesia. *Am. J. Obst. & Gynec.*, in press.



# TUBERCULOSIS OF THE LARGE INTESTINE\*

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THE subject of this paper, Tuberculosis of the Intestine, as given, is too comprehensive, as my real object is to present 4 cases of hyperplastic tuberculosis of the large bowel, and to deal more fully with that form, merely mentioning the other two varieties.

Intestinal tuberculosis manifests itself in three pathological forms: ulcerative, fibrous, and hyperplastic. The first, the most frequent, is a complication of pulmonary tuberculosis, occurring, according to Larimore and Fisher, in 60 to 90 per cent of all cases coming to autopsy. Kaufman claims that 90 per cent of adults having pulmonary tuberculosis have intestinal involvement.

The second is evidently a sequel to the ulcerative class, a result of the healing of the ulcers by the usual process of fibrous tissue formation, occasionally forming a stricture. The occurrence of such strictures, to my mind, is exceedingly rare, as the general constitutional involvement at this stage is too great.

The third variety, hyperplastic tuberculosis of the intestine, is a term to which Herrick objects, preferring the classification "tuberculoma," claiming that it is not a process of hyperplasia, but a chronic inflammation and infiltration of the bowel walls, and an overproduction of fibrous tissue.

This group has been regarded as quite rare, but I am inclined to believe that its rarity is more imagined than real. It remained unrecognized as clinical and pathological entity until 1890 when abdominal surgery directed attention to tumor-like formations occurring in the cecum, associated with tuberculosis. Durante, Billroth, and Hartmann and Pilliet,

later many other investigators, called attention to these growths which simulated carcinoma, clinically and macroscopically, but microscopically proved to be tuberculous. We are indebted to Hartmann and Pilliet for a detailed description in 1891 at which time the true character of these tumors was established. Further report was made by Hartmann in 1906, of 219 patients, operated upon with 45 deaths.

The intestinal distribution of the growth, in a collected group of 100 cases by Mummery is as follows:

Sigmoid flexure	6
Cecum	48
Cecum and ascending colon	39
Whole colon	4
Cecum, ascending and transverse colon	3

The 4 cases I am reporting are as follows:

Cecum	1
Cecum and ileum	1
Sigmoid	1
Rectum	1

The rarity of tuberculosis in the small intestine is illustrated by a recent article by Cunningham and Sneierson, reporting the ninth case.

## ETIOLOGY

The etiology offers difficulty of study; the fact is few surgeons have had opportunity to study more than 2 or 3 cases; furthermore, the cases have not been carefully studied. The only decision concurred in by all is that they are amenable to surgical interference.

Apparently no case has been studied sufficiently to determine whether the infecting organism is of the human or bovine type. I regret to plead guilty of the same negligence.

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It is evident that the occurrence of this form of tuberculosis is largely confined to the large gut. Its predilection for the

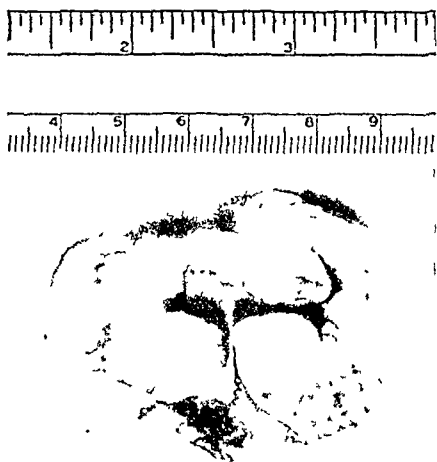


FIG. 1. Cross section through the sigmoid just proximal to the point of obstruction.

cecum and contiguous tissue cannot be more than surmised; that this site is selected because of the physiological function of the cecum, being an absorbing reservoir, makes for a longer delay of the intestinal content, in this portion of the intestine, most richly supplied with blood vessels, lymphoid glands, and Peyer's patches.

The rarity of association in pulmonary tuberculosis is illustrated by a study of tuberculomas, as well as a study of patients suffering from advanced pulmonary tuberculosis. In the Eudowood Sanitarium, with which I have been associated since its organization, as surgeon, we have treated 7698 tuberculosis cases, and never have we found a single case clinically pointing to intestinal hyperplastic tuberculosis, while the ulcerative form is present in the vast majority.

This is further borne out in a recent report by Rubin in 500 consecutive autopsies; 324 showed macroscopic tuberculous ulceration, or about 65 per cent. In the group below age of thirty-one, 78 per cent; above fifty years, 39 per cent.

The intestinal distribution was as follows: duodenum 1.6 per cent, jejunum

28 per cent, ileum 74 per cent, appendix 22 per cent, cecum 60 per cent, colon 42 per cent, rectum 11 per cent. There being no mention of the occurrence of the hyperplastic type, it is a fair assumption of its non-occurrence.

The question of the mode of entrance of the organism has suggested three theories: first by the direct entrance from the intestinal content; second by blood stream; and the theory of Shennan, of retrograde infection from the mesenteric glands.

The blood stream infection is suggested by Calmette, who believes that the bacilli pass through the mucous membrane, lodge in the regional lymphatics, and set up a pathological reaction, producing scar tissue and not ulceration.

Reasoning from clinical data, the greater frequency of the involvement of the cecum in pulmonary involvement, and the strong probability of intestinal involvement being due to swallowed tuberculous sputa, it would seem that the most plausible explanation of large gut involvement in the hyperplastic form is due to a weak or attenuated organism being ingested and lodged in a favored site or media, or due to a greater resistance on the part of the individual. In other words, a primary tuberculosis situated in the large intestine, in which the usual warfare goes on between the attack by the tuberculosis bacillus, and the individual, with the result that an inflammatory reaction is set up, with the production of fibrous tissue, which is the normal manner of healing in tuberculous healing.

The existence of the disease can only be determined after a most careful consideration of all the symptoms presented, and its existence must be inferred, rather than positively affirmed. Many of the symptoms are common to a number of affections, such as abdominal tumors, intestinal peritonitis, affections of the right kidney, and of the tubes and ovary of the female. The symptoms most commonly observed are weakness and loss of flesh, lasting over a long period, the evolution of the condition, although continuous, being slow and possi-

bly dependent upon a bacillus of attenuated virulence. Constrictive crises are usually noted, due to the arrest of the intestinal

teristic painful spot, there is absence of all general distention and of the fever so common in appendicitis. The tumors are

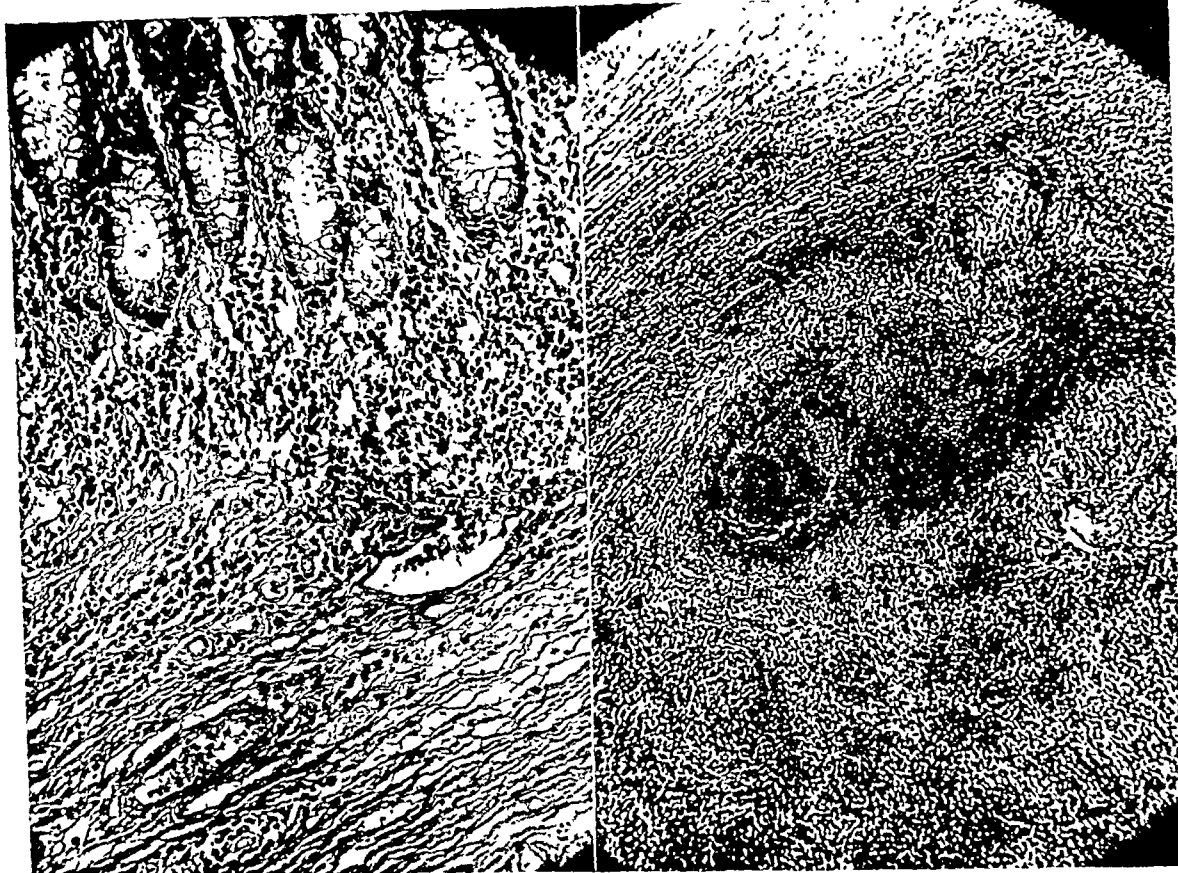


FIG. 2.

FIG. 3.

FIGS. 2 and 3. Fair preservation of glands of mucosa with intense round cell infiltration and fibrosis throughout submucous layer. Tubercle lying in infiltrated scar tissue just below serosa.

contents at the strictured points, with localized distention, possibly with visible peristalsis of the intestinal coils, the result of localized tympany.

These attacks are followed by cessation of the pain after characteristic borborygmi are heard, due to the passage through the obstruction of gas. These attacks of colic may or may not be attended by vomiting.

Moderate constipation in the earlier stages, with occasional attacks of diarrhea are common; but the latter symptoms may not be more pronounced and persistent than is often accidentally present in individuals without any intra-abdominal lesion.

Except in the latest stages, the vomiting suggests neither distinct intestinal obstruction nor appendicitis. There is no charac-

more or less mobile, steadily increase in size, are often multiple, and are apt to assume a cylindrical form; they are usually tender when gently palpated.

The differential diagnosis must be made chiefly from malignant tumor of some abdominal organ. The coexistence of pulmonary lesions seems very exceptional. These tuberculous conditions are more prone to occur at an earlier age than carcinomatous disease; nevertheless, so many young individuals do suffer from malignant tumors that this point is only of relative value. A tuberculin test may settle the question.

#### CASE REPORTS

CASE I. (B. S. H. No. 4998). White male, aged nineteen, June 11, 1930. (Dr. Stiles.)



*Past History:* Uneventful except that he had had slight attacks of the present illness over period of two or three years. These were charac-

quadrant, with an indefinite impression as to the presence of a mass in the region.

*Laboratory Report:* Leucocyte count was

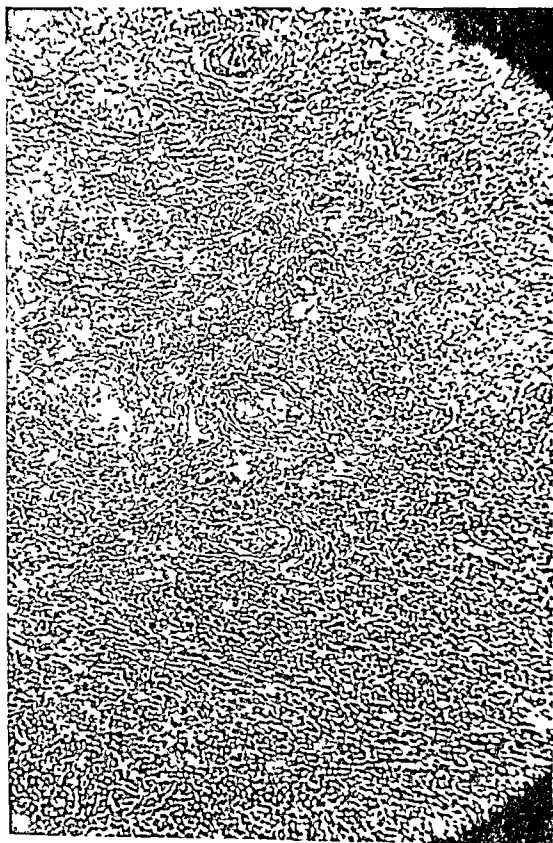


FIG. 4.

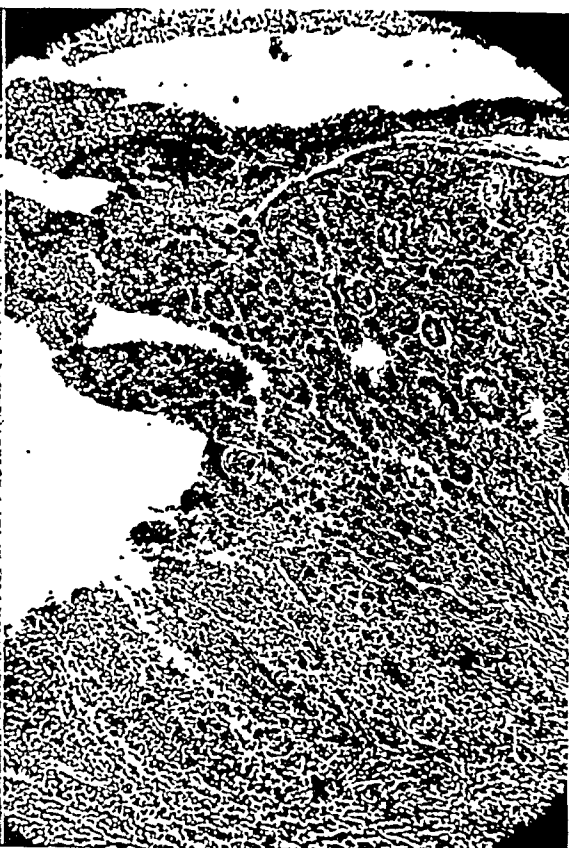


FIG. 5.

FIGS. 4 and 5. Replacement of old normal tissue with fibrosis, markedly infiltrated with round cells and showing giant cell formation. Replacement of mucosa with inflammatory tissue, markedly infiltrated with round cells. Few badly damaged mucosal glands survive.

terized by more or less pain in the epigastric region and nausea. Apparently not related to taking of food, and always cleared up within a few hours after onset. Bowels always regular.

*Complaint:* Pain in right lower quadrant of abdomen. Had been apparently well until two days before coming to hospital, at which time he had slight pain in the epigastric region, felt sleepy and thought he had fever. Was nauseated but did not vomit. Better next day but on following day pain returned and seemed to radiate from epigastrium down the right side of the abdomen, finally becoming localized in the right lower quadrant.

*General Examination:* Fairly good physical condition, quite toxic. Temperature 101°F., pulse 114.

*Abdominal Examination:* Revealed definite tenderness and rigidity in the right lower

16,400 with 80 per cent polymorphonuclears. Hemoglobin was 96 per cent.

*Preoperative Diagnosis:* Acute appendicitis with abscess formation.

*Gross Specimen Examination:* Consisted of a small portion of ileum, the cecum and part of the ascending colon. Appendix, which could not be demonstrated at first was found to make up the major portion of the tumor. The mass was about 10 cm. by 5 cm., fairly regular in outline and very firm in consistency. Upon opening the bowel, the mucosa appeared intact and there was no marked stenosis. On section, the lumen of the appendix was found to extend almost throughout the mass. The cut surface of the tissue was dense and fibrous and was of a dull white color.

*Microscopically:* There was a good deal of fibrous tissue and marked inflammatory re-

action. There was no evidence of malignancy. Tubercles and giant cells were found after much study.

*Result:* Patient discharged after twenty-seven days, and when last seen a short time ago was in good condition.

**CASE II.** M. C., aged forty, married, white male. September, 1929.

*Chief Complaint:* Pain in right inguinal region, urethral discharge.

*Past History:* Usual childhood diseases. Had right hernioplasty in 1915 and left hernioplasty in 1926. Also a gonococcic infection 1926.

*Present Illness:* Patient states that he received a gonococcic infection three years ago. This was followed by a discharge and burning on urination. Also had a sore on glans penis which was accompanied by enlarged inguinal glands, especially the right side. Since then has been having pain on right side and a morning drip.

*General Physical Examination:* Essentially negative except for absence of left testicle and a large rough hard mass around the rectal orifice resembling condylomata. Genitourinary studies including cystoscopy and x-rays of the kidney regions, both before and after injection of sodium iodide, resulting in a diagnosis of right renal calculus with pyonephrosis.

*Impression:* Gonococcic urethritis, chronic. Absence of left testicle. Lues. Chronic prostatitis. Prolapse of rectum. Probable renal calculus on right. Stricture of sigmoid colon, probably tuberculous.

*Blood Pictures:* Hemoglobin 44 per cent, red cells 2,680,000, leucocytes 16,700, polymorphonuclears 90 per cent.

*Postoperative Diagnosis:* Renal calculus, right, tuberculous. Tuberculosis of sigmoid colon, also stricture.

On September 28, 1929, right nephrectomy was done. This kidney showed a diffuse nephrosis, fairly large renal calculus and a number of small tubercles under the kidney capsule of the upper pole.

I saw the patient and after sigmoidoscopy, found a stricture of the sigmoid colon which I attributed to tuberculosis. On October 21, abdomen was opened by a left rectus incision, sigmoid brought to the abdominal wall and sutured to the peritoneum and skin. On opening the abdomen, I found numerous tubercles over the peritoneum.

On October 23, colostomy was completed with the electrocautery. The specimen removed at that time was a large thickened sausage-shaped mass which was submitted to Dr. Gichner for study, the report of which is given below.

*Laboratory Report:* Smear negative for gonococcus. Sputum negative for tuberculosis, many pus cells present.

*Laboratory Report:* Gross: Bowel is markedly thickened throughout. Kidney shows diffuse nephrosis.

*Macroscopic:* The wall of the intestines, all layers, is markedly thickened and there is great round cell infiltration throughout tissue. Here and there there is a mass of lymphoid cells, fibroblasts and typical giant cells. In no area does tissue show evidence of caseation.

*Microscopic:* Several hemorrhagic areas surrounded by round cell infiltration would strongly suggest tuberculosis; however, no typical tuberculous giant cells were seen. Further investigation of kidney reveals areas in which definite confluent tubercles are seen.

The patient ran a stormy postoperative course and died on October 31, 1929.

**CASE III.** L. M., Case No. 14,662, white female, married, housewife. (Under service of Dr. Herbert Blake.)

*General Examination:* Well-developed, well nourished woman. Negative except that symptoms pointed to abdomen.

*Chief Complaint:* Dull aching pain in right lower quadrant with history of beginning trouble January 16, 1930. Temperature slightly elevated, according to her statement, but no elevation of temperature on admittance. No nausea, no vomiting, but has had recurrent attacks of cramps, confined particularly to this region.

*Fluoroscopic Examination* showed viscerop-tosis. Some diarrhea at times.

*Abdominal Examination:* Small palpable mass over McBurney's point with tenderness and some rigidity. The clinical diagnosis was "appendicitis."

*Laboratory Report:* Blood pictures showed slight degree of anemia, red cells, 3,710,000, leucocytes 11,800, polymorphonuclears 78 per cent.

Urine, negative.

Stool, dark brown color, semi-liquid, much mucus, positive for blood (microscopic), negative for parasites and ova.

*Operative Procedure:* Was prepared for appendectomy but on finding this mass, 6 in. of small intestine and 3 in. of large intestine, including the cecal valve, were removed and then anastomosis done. Patient made a complete recovery.

*Postoperative Diagnosis:* Inflammatory mass of cecal valve and surrounding intestines, partial obstruction. Found no evidences of involvement of mesentery glands nor any indication of any pulmonary involvement.

*Laboratory Report:* Gross: Specimen consists of cecum, ileum, and appendix. The wall is everywhere tremendously thickened and shows an evenness of thickening which does not grossly appear malignant. In the cecum there appears to be one area of definite overgrowth involving the valve. This tissue is of greater hardness than the remaining portions.

*Microscopic:* The appendix shows considerable active inflammatory change involving particularly the lymphoid tissue, with here and there areas of degeneration, and other areas in which lymphocytes surround a center wherein the cells show degenerative changes. The walls of the gut are thickened, edematous, with areas of lymphocytic infiltration, at the borders of which occasional multinuclear giant cells can be made out. The pattern of the mucosa is fairly well preserved although there is some superficial necrosis. The accompanying lymph gland shows marked overgrowth of fibrous stroma and many degenerated areas where the lymphatic cells have been replaced with hyaline tissue.

*Final Examination:* Tuberculosis of cecum and ileum.

Last report from patient was that she had gained 8 lb. in weight, and felt perfectly well. Regular bowel movements. Appetite and general condition good.

*Note:* This case demonstrates the not infrequent confusion of appendicitis with cecal involvement in these conditions. Of course, the operation immediately disclosed a large mass which was considered inflammatory but was removed because of its obstructive symptoms, and a final diagnosis could not be made until microscopic sections were taken.

The lack of involvement of mesentery glands in such a large mass lessened the probability of a malignancy, as in these cases involvement does not ordinarily spread to the glands unless there are other tuberculous lesions in the patient.

CASE IV. A. S. colored, aged thirty-two, married, laundress. October 1919.

*Chief Complaint:* Pain in back, lower part of abdomen. Pain continues day and night. Constant discharge from bowels.

*Family History* negative. Has had one child. No history of tuberculosis. Denies venereal disease. Other than childhood diseases, had been healthy.

*Present Complaint:* Patient noticed lump in rectum which often protruded and caused her to go to the toilet frequently. With treatment by home remedy, it returned to place and pain ceased. Three months later pain returned and 3 or 4 more lumps appeared, compelling her to have defecation every five minutes, with great straining and bearing-down pains. These symptoms continued up until the present time; occasionally red blood and small clots had passed with her stools. Pain had grown worse progressively and localized itself particularly in the rectum and lower part of the back. At times passed quantities of mucus and pus, always had straining. At present moment has incontinency of feces. Complains great deal of gas and pain.

*Habits:* Negative.

*General Physical Examination:* Head, neck, heart, abdomen, and lungs normal. No genitourinary symptoms with the exception of frequency of urination. Menses have been regular until past month when one period was missed. During the past year has lost a great deal of weight. Always has sensation of full feeling in rectum.

*Examination:* Several condylomata with several fistulous tracts leading into perianal tissues.

Internally, mass about 5 cm. above sphincter, involving entire rectum and protruding and lifting itself into the vagina, but no involvement of vaginal mucosa. Vagina clear except profuse discharge. Mass is irregular in shape, lumpy, several ulcerations. Bowels obstructed to lumen about size of lead pencil.

*Laboratory Report:* Wassermann reaction.

Vaginal smears: many pus cells, negative for gonorrhea.

Urine: negative except few pus cells.

*Diagnosis:* Stricture of rectum, probably syphilitic in origin. Fistula in ano. Small piece of tissue removed for examination, stricture dilated. Following diagnosis, patient declined subsequent operation.

Following her dilatation, three weeks later patient had improved generally. Bowel movements, well-formed stool and no diarrhea.

Specimens were submitted to the hospital pathologist who gave as his impression from microscopic section that it was a syphilitic stricture. Two studies were made by Dr. Bloodgood and his results were as follow:

Microscopic: The section showed granulation tissue filled with numerous tubercles and giant cells. The histological picture of tuberculosis. In the center of the section, surrounded by the tuberculous granulation tissue, there are a few dilated mucous glands of the rectum, mucous membrane, but here there is no picture of adenocarcinoma. The glands are dilated, lined by a single layer of columnar epithelium and filled with mucus.

This case illustrates involvement of the rectum with hyperplastic tuberculosis. Careful examination was made of the lungs and no evidence of involvement could be seen.

An operative procedure to have relieved this condition would necessarily have destroyed the sphincter mucosa and given loss of bowel control. The suggestion was made to the patient to have a colostomy done primarily, and then to remove the entire rectum or as much as would have been necessary. This she declined.

The high points in the history of these cases:

Diagnosed as acute appendicitis with abscess. Chest negative for tuberculosis. (Case of Dr. Stiles.)

Diagnosed as rectal stricture, syphilitic. No clinical signs of tuberculosis. (A. S.)

Diagnosed as appendicitis, chronic. Intestinal stricture, with appearance of tuberculoma. Tubercles, peritoneum. Tuberculous kidney. (Dr. Blake, M. C.)

The unusual: One located in rectum.

One, tuberculosis in other organs.

Results: Three good operative results.

One death of general asthenia.

## CONCLUSIONS

This condition is not so rare as is believed. An operation is essential, and results are good. Preoperative diagnosis is impossible. The condition demands immediate relief. Careful microscopic study makes for a favorable or bad prognosis. More study should be done to determine the kind of bacillus, bovine or human.

I am indebted to Dr. Cleo D. Stiles, Jr., and Dr. J. K. B. E. Seegar for the privilege of reporting their case, a patient at St. Agnes' Hospital. I am also indebted to Dr. Herbert Blake for the privilege of reporting his case, a patient at the West Baltimore General Hospital. The other 2 cases occurred at the West Baltimore General Hospital and at the University Hospital, Department of Proctology, under my service. I should like also to thank Dr. Manuel Gichner, Pathologist at the West Baltimore General Hospital for the interpretation of the photomicrographs, and to Dr. Carl Clarke, Head of the Art Department at the University of Maryland, for their preparation.

## REFERENCES

1. ANDERSON, J., and MUNRO, W. T. Tuberculous hyperplasia of large intestine. *Edinburgh M. J.*, 1031, 159-173.
2. CALMETTE, A. and GUERIN, C. Origine intestinale de la tuberculose pulmonaire. *Ann. del'Inst. Pasteur*, 19: 601, 1905.
3. CUNNINGHAM and SNEIERSON. Chronic hyperplastic tuberculosis of ileum. *AM. J. SURG.*, 12: 131, 1931.
4. DENANCREDE, C. B. and BUTTERFIELD, E. E. Hyperplastic tuberculosis of the intestine. *Surg. Gynec. & Obst.*, 3: 302, 1906.
5. HARTMANN, *Lancet*, 2: 1592, 1906.
6. HERRICK, F. C. Tuberculoma of cecum, hyperplastic tuberculosis. *Ann. Surg.*, 81: 801-820, 1925.
7. LARIMORE, J. W., and FISHER, A. O. Tuberculosis of cecum. *Ann. Surg.*, 83: 496-522, 1926.
8. LOCKHART-MUMMERY, P. Diseases of the Rectum and Colon. N. Y., Wood, 1923, p. 489.
9. RUBIN, E. H. Tuberculosis and secondary intestinal tuberculosis; etc. *Am. Rev. Tuberc.*, 22: 184-202, 1930.
10. SHENNAN, T. The morbid anatomy of tuberculosis in man. *Lancet*, 1: 595, 1914.



# RIGHT HEMICOLECTOMY WITH ILEOCOLIC TUBE DRAINAGE\*

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WITHOUT specifying all the pathological conditions or changes of the right colon that require right hemicolectomy, I have selected two illustrative lesions for which this operation had been performed.

The intestinal ends were joined by an end-to-end union and an ileocolostomy rubber drainage tube was inserted and so arranged that it demonstrated some useful features of practical value.

If I interest readers in a single problem in the Art of Surgery: namely, right hemicolectomy, it may serve to focus attention on other latent opportunities for practical trial and research in this field.

Recently the exaltation and glorification of the Science of Surgery has tended to obscure the importance of the Art of Surgery.

Discussions as to the relative importance of the divisions of Surgery, Art versus Science, are never satisfactorily ended. Strong and earnest advocates of each class are quick to emphasize and express their preference, depending entirely on personal inclinations and beliefs.

Believing as I do that the ideal surgeon requires excellent qualities of head, hand, and heart, and must be a composite thereof, I hold no brief for the pure technician, the exponent of manual dexterity in our ranks, who often is so one-sided that he sets aside real thinking, sound reasoning and good judgment as items of secondary importance.

It must be appreciated that science may envisage new fields and explore the unknown, and that a broad and sympathetic encouragement must be given to such work, that the results thereof be carefully estimated, appreciated and accepted only

when worthy. In surgery particularly, it is important not to follow too quickly nebulous fancies, speculations, and unproved theories hastily accepted when garbed as science.

It can be definitely stated that pure science cannot advance alone from its test tube, animal experimentation, laboratories or the morgue. Such work must be transported, translated and activated by competent and skilled craftsmen of the Art of Surgery into measures useful for the living.

It continues true, that the demand of humans is that, when required, operations upon us be done by trained mechanics, not theorists; skilled performers, not laboratorians; but by competent surgeons trained in the Art of Surgery.

E. Starr Judd<sup>1</sup> in a presidential address before the Western Surgical Association concluded as follows: "Perfection of the Art of Surgery can be obtained only by constant practice, and only those who are willing to spend much time and effort in the development of this sort of craftsmanship, along with their studies of the Science of Medicine, will have an opportunity to become the real Artists of Surgery."

Surgically, the entire colon may be divided into a right and left part. Important differences in these two halves have made this somewhat arbitrary cleavage of practical and basic use for any operative consideration directed thereto.

Embryologically, the right colon was derived from the midgut, the left colon from the hindgut. The superior mesenteric artery through its branches and arches of the ileocolic, colica dextra and colica media give an adequate and a rich blood supply to this part of the colon, whereas

\* Read by invitation before the Brooklyn Surgical Society, January 2, 1931.

the left colon supplied in main by the inferior mesenteric artery and a left branch of the colica media does not receive so generous a vascular series of arches of blood (Fig. 1). The entire colon maintains its blood vessels on the inner leaf of the mesentery. Its lymphatic system is carried with it. The outer leaf may be considered an avascular layer.

Usually, the contents in the right colon are fluid and therein the number of bacteria is fewer and less actively infectious than in the left half. Obstructions on the right side are often less complete. The general effects of such a blockage are not so disturbing or toxic. Local intestinal wall damage is better tolerated.

All the principles that are essential for the removal of the right colon have been well accepted and standardized for its accomplishment. The type of anastomosis best performed for the bowel ends continues to be vigorously debated.

An essential requirement is a free and avascular mobilization of the ascending colon by splitting the outer leaf of peritoneum near its attachment to the posterior parietal wall, liberating the proximal half of the transverse colon by lifting the omentum from its attachment to that area and severing the ileum about 6 in. from the ileocecal junction.

It has been my plan, first to start on the ileum by sectioning that bowel with the actual cautery (Fig. 2) then doubly clamping the ileal mesentery toward the ileocecal area. The second step has been to split the outer mesenteric leaf of the cecum, ascending colon and hepatic flexure (Figs. 3 and 4) permitting this portion of the colon to rise high up, after which the omentum has been detached from the transverse colon (Fig. 5). All this completed will permit these parts to hang loosely and easily on its inner or vascular blade so that the blood vessels can be clearly seen, doubly clamped, divided and tied. Attention to the right ureter and the right spermatic vessels in this area must be observed.

Often the greatest difficulty is encountered at the corner of the hepatic flexure. Here, the colon must be carefully stripped

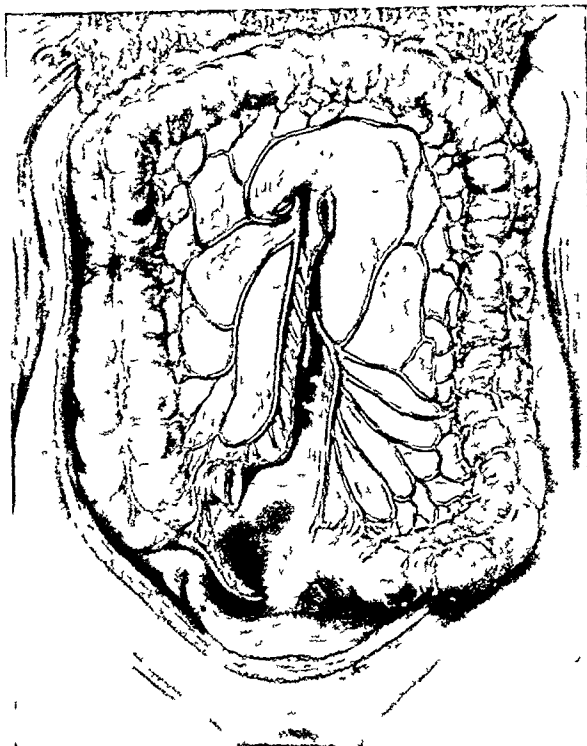


FIG. 1. Anatomical study of colon to visualize vascular arches.

downward and inward and the supporting ligament and vessels carefully isolated and tied. Guarding the duodenum at this point is necessary as injury to this structure is not infrequent. Now, the transverse colon is divided between clamps (Fig. 6) and the entire attacked intestine with a large part of its mesenteric attachment is removed.

Finally, I have united the ileum to the transverse colon with an axial, straight-line, or end-to-end union (Fig. 7).

I have introduced a rubber tube (No. 20 F. catheter) into the ileum, through the stoma and into the transverse colon, to provide intestinal drainage and maintain the patency of the stoma (Fig. 8). Separate openings as eyes in the tube are provided for both the transverse colon and the ileum.

About 4 in. from the anastomosis, this tubing, after its introduction into the

ileum, is fixed at its point of aperture with two rows of purse-string sutures and the distal or free end of the catheter is

3. Edge tension
4. Hemorrhage
5. Marginal constriction

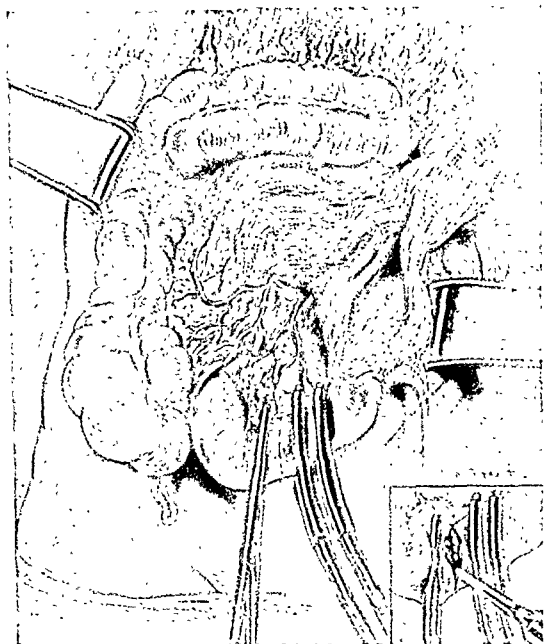


FIG. 2. Ileum sectioned with cautery after three clamps have been arranged thereon. One crushing clamp is placed distally and two flexible rubber sheathed clamps placed proximally to line of section. When caudally placed ileal clamp is removed, there will be sufficient bowel to perform ileocolic anastomosis.

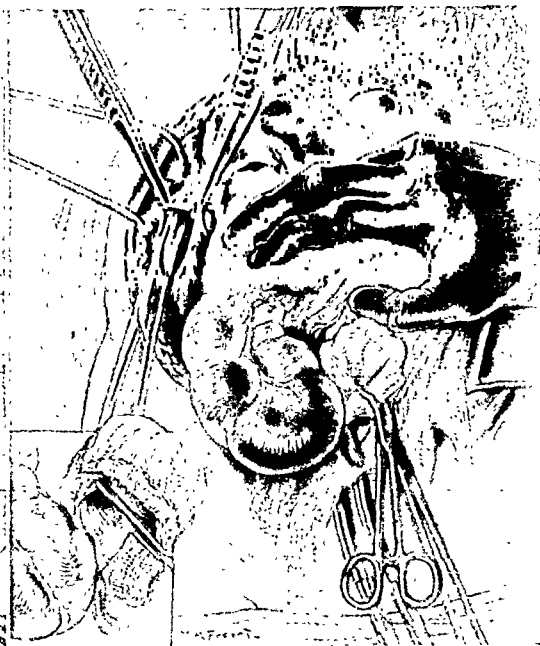


FIG. 3. Splitting outer leaf (avascular) of peritoneum, permits rapid and bloodless scissor and finger mobilization of cecum and ascending colon.

carried under and through a small opening made into the great omentum which had been detached from the sectioned transverse colon (Fig. 9). This allows that portion of the omentum to lie flat over the anastomosis. No suturing is required.

Through a separate stab-wound into the abdominal wall or from the original wound itself, the catheter may be allowed to have its exit. This depends upon how the catheter will best arrange itself without the least distortion.

The results of every recent bowel anastomosis axial, lateral, or end-to-side, involve similar difficulties that vary only in degree. These may be divided in a primary or immediate group, and a secondary or delayed group. Under the *primary*, we list:

1. Local soiling
2. Inadequate blood supply

6. Stoma, immediate size and patency
7. Coverage
8. Infectivity
9. Type of intestinal content.

In this group are errors mainly of technical character.

*Secondary or delayed group:*

1. Marginal gangrene
2. Closure of stoma due to excessive contractions
3. Excessive exudate narrowing the stoma
4. Marginal abscess
5. Local paresis
6. Local retention of fecal contents
7. Ballooning of blind stumps
8. Blow out of closed ends
9. Local abscess
10. Kinking of segments
11. Fecal fistula.

In this second group, many of the mentioned factors interfering after a satisfactory anastomosis has been completed,

occur as a result of the failure of fecal contents, gas, fluids or solids to be properly propelled forward, causing increased ten-



FIG. 4. Cecum and ascending colon rolled over. Blood vessels can be viewed, clamped, cut and tied.



FIG. 5. Great omentum is detached from transverse colon on right side to liberate it and help mobilize hepatic flexure.

sion on the suture lines, thus permitting the infective material to press on to freshly

coaptated bowel edges and thereby damaging the stoma and its component parts.

Although a classification into such groups may not be sharply defined and exact, it will serve to a better understanding of some of the hazards inherent in all anastomoses and of measures to decrease them.

The difficulties which not infrequently confront the surgeon in carrying out operations on the large and small intestine are to a considerable degree overcome by his familiarity with the established principles of intestinal surgery; his ability to employ technical methods of proved value and to utilize the various mechanical devices which, in the development of surgery of the gastrointestinal tract, have been employed to meet special conditions arising during operation.

Of the mechanical devices the rubber tube, I believe, deserves more general and favorable recognition than is at present accorded it. Its usefulness in certain intestinal operations has been very evident, and the results of such operations so gratifying, that it seems appropriate to

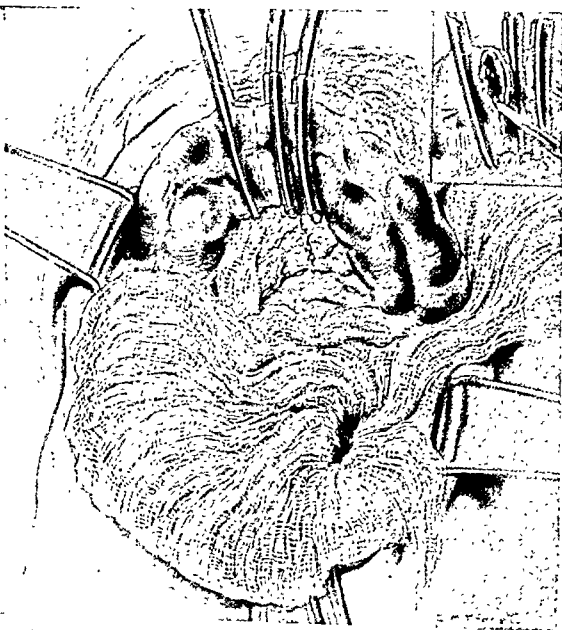


FIG. 6. Transverse colon sectioned with cautery after three clamps have been placed. One crushing clamp proximally and two flexible rubber sheathed clamps distally to line of section. When rubber covered clamp nearest cut end is removed, there will be ample bowel to perform ileocolic union.



record these two instances of right hemicolectomy wherein it has been employed.

Exactly how, when, and where rubber

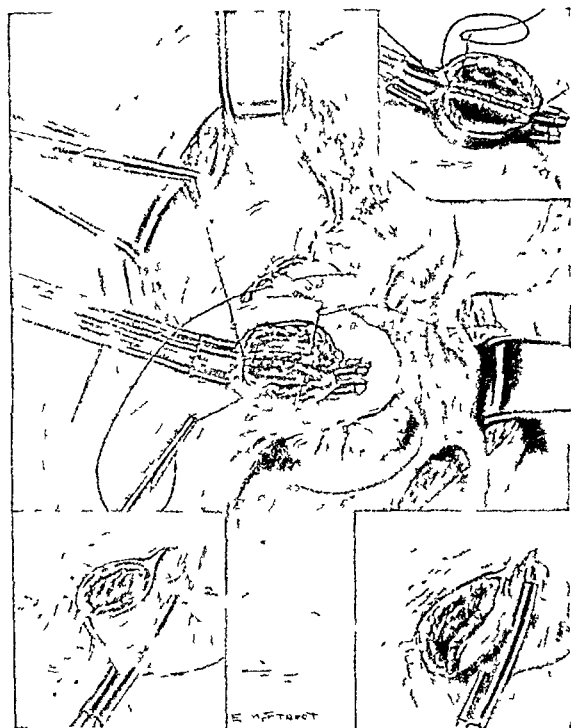


FIG 7. End-to-end anastomosis of ileum to transverse colon. Insets, to show how ileal end may be widened by split on antimesenteric border to approximate same circumference as cut end of transverse colon.

tubing first made its introduction to intestinal surgery, and the subsequent steps thereafter will not serve any particular purpose in this paper.

In 1910, Balfour<sup>2</sup> reported its value in resections of the left colon, especially at the rectosigmoid, a procedure that became generally known as the Balfour tube resection. He, however, gave credit to his predecessors, Rutherford Morison, Lockhart Mummery, and other English surgeons.

It has been the frequent and better experience of many surgeons that tube drainage is a highly desirable and essential part of the technique in many resections with union on the left colon. To utilize a piece of rubber tubing through the stoma and to carry it through the anus to the external surface provides a ready exit for fecal contents. It also controls the patency

of the stoma and furnishes a scaffolding for plastic exudate to form upon. As a splint, it maintains the position of the segments of intestine at rest and free from angulation.

Little mention has been made of the use of rubber tubing for similar purposes on the right colon. Occasionally as a direct enterostomy tube it has been set into the ileum about 7 in. above the ileocolic union. More often, it has been employed as tube drainage for the open ends of the colon or ileum.

Horsley,<sup>3</sup> after speculatively considering the advisability of a rubber tube drainage through the stoma of a direct ileocolostomy union, employed this method in a case. He, however, introduced the tube through the colon, stoma and then into the ileum.

Unlike the step procedures required for the left colon, as a general measure resections of the right colon are accomplished in one stage. The restoration of the continuity of the intestinal tract may be performed in many ways. Probably the most popular union of ileotransversostomy continues to be the lateral one. Next in the order of frequency is the end-to-side operation and finally the axial or end-to-end anastomosis.

There seems to be a tendency lately, however, to reverse this order. John F. Erdmann<sup>4</sup> has long been a user of the line type of anastomosis.

The objectors to the lateral anastomosis have maintained that a finished procedure leaving two blind stumps and three suture lines carries a serious defect. There are too frequently recorded instances of early and late blow outs of the blind ends. Longitudinal incision of the transverse colon and ileum interferes with a large area of neuromuscular activity thereby subjecting the local area to excessive paresis, local contractions and greater interference to the onward propulsion of fecal contents.

End-to-side anastomosis carries one-half of these objections whereas axial or end-to-end anastomosis reduces to a minimum all of the faults of theoretical or practical consideration.

Nevertheless, certain difficulties will occasionally arise even under the most favorable conditions and effort, which

cramps centered to the right lower quadrant. She had no nausea or vomiting, but felt distinctly chilly.



FIG. 8. Introduction of rubber tube with two eyes, into ileum, through ileocolic stoma and into transverse colon.

may be partly overcome by the use of an ileocolic tube, such as I have described, to conduct a large part of the intestinal contents to an external surface. This tube, as described and pictured when withdrawn from the intestine, leaves an opening in the ileum which usually closes spontaneously and promptly.

**CASE 1.** B. R., a female, aged forty-three years, was admitted to the Israel-Zion Hospital, July 1, 1930, with a temperature of 100°F.

**Marital History.** The patient had been married seven years and had four children. The last pregnancy occurred two years ago.

**Past History.** She recalled that five weeks after her last delivery, she developed mild lower abdominal pains. The patient described the pain as "pin and needle-like," intermittent, lasting an hour at times. She was very indefinite as to its exact location. Occasionally the pain radiated to both flanks. It was never limited to the right lower quadrant. No history of persistent nausea, belching, vomiting, cramps or diarrhea could be obtained.

**Present Illness.** Eight hours before hospitalization, patient complained of severe abdominal

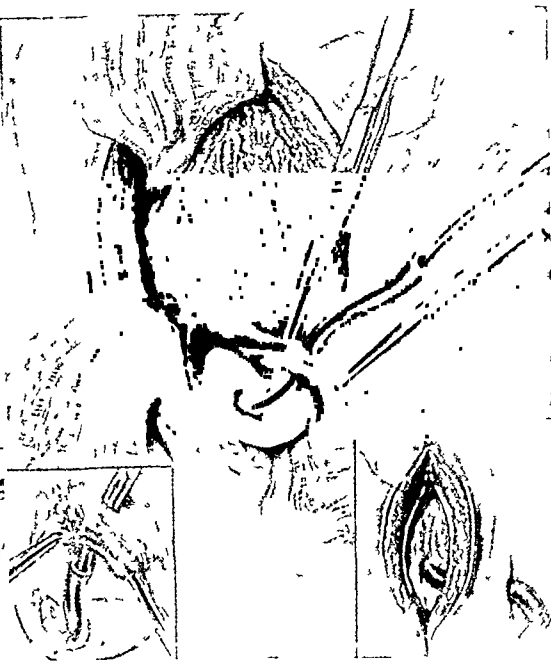


FIG. 9. Tube carried through omentum which will protect ileal aperture and help close it. Inset, rubber tube withdrawn through stab incision in abdominal wall.

**Physical Examination.** Patient is an obese female moderately ill. The heart was not enlarged; the lungs were noted to have râles due to chronic asthma. Abdomen was only slightly distended. In the right lower quadrant was a wide area of local tenderness with definite resistance of the underlying muscles. Rebound tenderness was marked. It was estimated that the most tender spot was over McBurney's point.

**Vaginal Examination.** No pelvic pathology. Urinalysis (faint trace of albumin), and blood examinations (total white blood cell count 12,500; 76 per cent polymorphonuclears).

**The Preoperative Diagnosis.** Acute appendicitis.

**Operation and Operative Findings.** Through a right gridiron or McBurney incision, the cecum was found to be involved by a mass formation the size of a fist. The tumefaction occupied most of the outer and lower half of the cecum. The pathological diagnosis was indeterminate; carcinoma of the cecum received the most consideration.

The specimen when incised postoperatively showed a calloused ulcer of the outer side of the

cecal wall. It had raised smooth edges. A rounded opening about  $\frac{1}{2}$  in. in diameter led into a large pocket within the cecal wall. Purulent fluid was in the retention cavity. The cecal wall was tremendously thickened by inflammatory tissue.

The operation performed was an ileotransversostomy with ileocolic tube drainage carried through a separate stab incision in the abdominal wall. The drainage tube was removed ten days after the operation. The patient left the institution in three weeks with both abdominal wounds healed.

*Pathological Report.* (Dr. Max A. Golzieher.) Diverticular ulcer and abscess of the wall of the cecum. The wall of the intestine is considerably thickened. This thickening is most conspicuous in the outer layers. The whole wall shows diffuse inflammatory infiltration of subacute type. In the center of the wall at about equal distance from the mucosa and the serosa there is a round cavity which is filled with fecal matter. The wall of this cavity is completely necrotic and the necrotic tissue is surrounded by an area of intense leucocytic infiltration. Some sections show remnants of viable tissue in the wall of this cavity and these remnants include also shreds of intestinal mucosa.

We are dealing with an intestinal intramural diverticulum with inflammation of the intestinal wall, partly of longer standing and partly of an acute gangrenous type.

CASE II. A. R., a female, aged sixty-two, admitted to the Jewish Hospital, July 9, 1930.

*Past History.* Essentially negative.

*Present History.* Apparently there was no previous complaint referable to her present illness until four weeks ago. Since then the patient has been complaining of abdominal pains, especially on the right side. One week ago, she sought attention at the out-patient department for pain in the right upper quadrant. She remarked that she was losing weight and that lately she confined herself to a fluid diet. Yesterday an attempt to administer castor oil preliminary to a radiographic study caused violent abdominal cramps and vomiting. She could pass no flatus or stool and hospitalization was advised.

*Physical Examination.* A medium sized, somewhat emaciated female, acutely ill, groaning with pain. Abdomen, slightly distended, no visible peristaltic waves or distended intestinal loop were noted.

The abdominal walls were soft and flabby, the skin thin and lax. In the right lower quad-

rant a distended and very sensitive cecum could be distinctly felt. Only on deep and firm pressure was any tenderness in the right upper quadrant elicited.

*Preoperative Diagnosis.* Partial intestinal obstruction due to carcinoma of the right colon.

*Operation and Operative Findings.* July 11, 1930. Through a right rectus incision, an annular constricting neoplastic mass near the hepatic flexure was demonstrated. Glands in the contiguous mesentery were enlarged and seemed to be involved. The ascending colon and cecum below the growth were moderately widened.

A right hemicolectomy with an end-to-end ileotransversostomy was done. It was supplemented with an ileocolic rubber drainage tube, the end of which was brought out at the lower angle of the wound.

*Notes.* Two days of treatment preliminary to operation were extremely helpful. Colonic irrigations and warm abdominal stupes helped to relieve the obstruction. Gastric lavages relieved the vomiting and helped in part to decompress the gastrointestinal tract. Intravenous glucose solution, hypodermoclysis of similar solution helped to restore the fluid balance.

*Postoperative Course.* Several weeks after operation, a pelvic abscess that developed in the post cul-de-sac required a post-colpotomy. The patient was discharged four weeks later.

*Pathological Report.* (Dr. Max Lederer.) Microscopic specimen 35 cm. of colon and 45 cm. of ileum. About 15 cm. below the ileocecal valve, there is a marked induration of the wall involving the entire circumference of the gut. On section the inner aspect of this mass is marked by an ulceration with heaped margins and roughened eroding base. The lumen is almost completely occluded by this mass. The lymph nodes on the serous coat opposite this area are firm. Examination shows the wall of the gut to be the seat of an unrestrained growth of intestinal glands which invade the entire muscular coat, extending to the serosa. The lesion is an adenocarcinoma of the colon. There is no microscopic infiltration of the sectioned lymph node by malignant cells.

#### REFERENCES

1. JUDD, E. S. The art of surgery. *Surg. Gynec. Obst.*, 51: 479, 1930.
2. BALFOUR, D. C. The utility of rubber tube in intestinal surgery. *Surg. Gynec. Obst.*, 31: 184, 1920.
3. HORSLEY, J. S. Resection of the caecum and ascending colon. *Ann. Surg.*, 69: 25, 1919.
4. ERDMANN, J. F., and CLARK, H. E. Tumors of the caecum. *Ann. Surg.*, 85: 722, 1927.

# REDUCTION OF FETAL MORTALITY

IN AN OBSTETRIC SERVICE\*

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**A**N unusually large percentage of fetal deaths in the obstetric service at the Louisville City Hospital during the year 1929 prompted us to make use of every available measure to have a better result in the following year.

We lost 142 babies in 1263 deliveries. Through proper deductions, absolutely nonviable babies, untreated syphilitics, toxemias of the mother and congenital anomalies, 82 could be eliminated, leaving 60 fetal deaths, a percentage of about 4.5, which will after all compare favorably with reports from similar institutions.

In order to reduce fetal mortality and especially to prevent stillbirths, every morbid condition in the mother must be detected and treated during her pregnancy.

An early examination in pregnancy should lead to the recognition of uterine displacements and by the use of a supporting pessary until after the fourth month, abortions on that account should be preventable.

Little beyond the recognized procedures can be done in saving the generally premature fetus in placenta previa and ablatio placenta as the loss of blood on the part of the mother is an additional factor in causing fetal mortality.

It should now be recognized that both conditions are absolute hospital procedures, which except in multiparae with well dilated cervixes, demand cesarean section.

If the fetus is not too premature and in good condition it should have the benefit of a cesarean delivery rather than the certainty of absolute destruction when its body is used in the vaginal delivery as a tampon in order to assure a safe delivery

for the mother. This is especially advocated in central and partial placenta previas as the operation renders the delivery safer for the mother as well.

If the vaginal route is selected in placenta previa and practically in the delivery of all premature babies, especially in primiparae, the principal cause of fetal death, cerebral injury, and intracranial hemorrhage, can be averted to some extent by the use of dilating bags to efface the cervix and of an episiotomy to remove the hazard of a tense perineum.

The present therapy of hyperemesis leaves but little to be desired in that direction and interruption of pregnancy with consequent fetal death should now occur very rarely.

At times, however, over-confidence in our therapy is rudely shaken, when a patient who has ceased vomiting and is taking an abundance of food presents sudden signs of collapse. We still have no reliable means of recognizing such extremely toxic cases. Very early interruption of the pregnancy might save them, but we have no criteria upon which to base the indication of the time for such a radical procedure.

Our therapy has been simplified considerably by the use of the Soresi blood transfusion apparatus and a thermos bottle outfit for the intravenous administration of glucose at a constant temperature and rate.

With proper prenatal care, the incidence of eclampsia can almost be eliminated.

It must not be forgotten, however, that with all our precautions, an indiscretion in diet on the part of a patient may precipitate

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an attack. In practically all of our eclampsias we get the history of some dietary indiscretion. Pork chops, hot tamales, hot dogs, raw oysters, bacon and greens and lobsters figure in such recitals and although it is not claimed that such indiscretions are the cause of eclampsia, they certainly precipitate an attack in apparently healthy gravida.

It is claimed that in such instances digestion is interfered with, fermentation of the food products takes place and the toxins absorbed from the decomposed food with those already circulating in the system from the pregnancy, are sufficient to precipitate the eclampsia.

Especial stress accordingly should be put on dietary restrictions in the last months of pregnancy, to prevent eclampsia and fetal deaths on that account. Attention will also be necessary very soon to curb the excessive smoking and drinking of some of our young women, especially during the period of gestation.

In the late toxemias the placenta always shows extensive areas of white infarcts. These are practically inert areas in the placenta and if they are sufficiently extensive they interfere with fetal nourishment and may cause either fetal death or premature expulsion. Again, such devitalized areas are dead spaces in the placenta and the absorption of toxic products from such areas into the maternal circulation will result in fetal death.

This naturally brings up the question of delivery in toxemic patients. From the foregoing it is evident that even if the toxemia is apparently controlled in the mother, the life of the fetus is in jeopardy on account of the absorption of toxins generated by the infarcts of the placenta and the diminished functioning of the placenta due to such devitalized areas. It would seem, if the fetus is viable, that delivery should be instituted as soon as the mother is in a safe condition.

A great number of our fetal deaths were due to premature births in syphilitic women both treated and untreated. The fetal

mortality was of course much greater in the untreated cases. It is advocated by some that a Wassermann test be made in every case of pregnancy. That is hardly practical in all circumstances. What is of more importance, it seems to me, is to gather statistics as to the condition five, ten and fifteen years after the birth of a living child from such a treated syphilitic mother, to determine whether it is a mentally and physically useful member of society or whether by our therapeutic measures we are simply bringing into the world morons, habitual criminals and physically unfit human beings. It is well also to learn that even in women who have had intensive treatment for syphilis throughout the period of pregnancy, the baby apparently free from taint at birth may show extreme symptoms of neurosyphilis one or two years later, as happened in a private case of mine. In plants and animals every effort is now being made to improve the stock by weeding out the unfit. It seems to me that it will soon be necessary to apply the same principle to human procreation. Given a syphilitic mother or father or both, the product of such a conception is surely impaired from the onset and when its physical being is once established, intensive treatment of the mother may prolong the period of gestation and give a live baby but it surely cannot remove the taint of its original inheritance. Nature has wisely decreed that if such cases of conception are left alone that the expulsion of an immature or macerated fetus takes place generally between the sixth or seventh month and we may well question whether our therapy is an improvement upon such destiny.

The very construction of the syphilitic placenta is such as to preclude the possibility of a living infant. The syphilitic placenta is larger, heavier and paler than normal, both the size and weight being due to edematous infiltration. The individual villi are larger and closely packed. The pallor is due to the obliteration of many blood vessels by thrombosis, and there is a

perivascular fibrosis which in time obliterates the vessels by pressure and accounts for the thrombosis.

Under the microscope syphilitic villi appear abnormally large, opaque and irregular in shape with swollen ends. The almost complete obliteration of the intervillous space, due to the increase in size of the villi, the inflammatory reaction in the intima and media of the vessels of the villi, the cellularity of the stroma and the apparent invasion of the stroma by the syncytial layer are all characteristics of the syphilitic placenta. Consequently the death of the fetus in syphilis is not due to the effect of the disease upon its organs, but upon the destructive changes produced by the syphilitic infection upon the structure of the placenta. It may also be presumed, then, that intensive treatment of the syphilitic mother during her pregnancy largely expends its force in preventing these destructive changes in the placenta making it possible for the mother to carry her syphilitic infant to full gestation.

Denmark has set the world a remarkable example of the efficient handling of the syphilis problem and it will be well for other nations to follow its precepts.

In my opinion the proper course to pursue at present is to inform the husband and the wife, that untreated she will give birth to a premature living or dead syphilitic fetus. That if properly treated she may give birth to a living child that will probably have syphilis. This cannot possibly interfere with any religious principles and will place the responsibility where it belongs.

A considerable number of fetal deaths will always occur from complications of labor. In breech deliveries improper extraction and twisting may result in fractures of the spine, injuries to the cord and suprarenal glands, and cerebral hemorrhage, all due to haste or wrong technique. In consequence external cephalic version is advocated by many in breech presentations. That has not been the custom in our clinic. Rather, have we tried to perform

all steps in the delivery of such cases with gentleness and deliberation, taking plenty of time in bringing down the after-coming head, refraining from traction on the neck and aiding at once with the forceps if the after-coming head does not come down readily.

Forceps deliveries will account for many fetal mortalities. Premature infants should never be delivered with forceps as but slight compression of the soft head will initiate a cerebral hemorrhage. With the cervix properly dilated with a large Vorhees bag and an episiotomy when the head reaches the perineum, spontaneous delivery should be possible in all such cases. High forceps operations should be abolished. When the head will not descend into the pelvis with full dilatation then it is an indication of disproportion and it requires discrimination then to decide between a version and a cesarean section.

In middle and low forceps operations the safety of the procedure depends upon an accurate diagnosis of presentation and position, made by the location of the sutures and fontanelles and verified by the posterior ear. Then there should be a careful cephalic forceps application with extraction by careful, gentle traction in the proper direction, with release of the forceps blades between pains, to minimize cerebral injury.

In cases of contracted pelvis we have been over conservative and have lost a number of babies by conscientiously giving the mother a prolonged test of labor, when by an earlier cesarean section a living child might have been secured.

It is unfortunate that the real test of labor and the capacity of a given pelvis cannot be definitely determined until after full dilatation and rupture of the bag of waters and as is well known with each hour of such delay the prognosis for both mother and child is more unfavorable.

If we consider that in the best of circumstances the fetus, forced by nature through such abnormal passages, is subjected to the danger of more or less cerebral hemor-

rhage, it may justify us in prompter resort to abdominal delivery when pelvic measurements and high riding of the fetal presenting part indicate at least a difficult vaginal delivery.

Abnormalities of the umbilical cord will at times lead to disaster. The short cord will indicate its presence by delay and recession of the presenting part after each pain in the second stage of labor. It may lead to premature separation of the placenta and fetal death unless prompt measures are instituted to terminate such a situation. In prolapse of the cord the patient should at once be placed in the Trendelenburg position, over the rungs of a chair placed on the bed if the condition occurs in a private house. This generally removes the pressure of the presenting part upon the cord and circulation in its vessels is re-established. Further steps in the delivery can meanwhile be carefully planned.

Every now and then a baby is born which, after resuscitation seems to breathe with difficulty and presents signs of venous congestion, the so-called "blue baby." The general belief has been that this was due to delayed closure of the foramen ovale but now we learn that it may be caused by hyperplasia of the thymus gland. Apparently sudden engorgement of this gland may result from too vigorous attempts at resuscitation, especially bending and twisting the newborn baby to make it breathe, together with rough wiping of the throat to remove mucus. The actual cause of death in these blue babies can of course only be ascertained post mortem, and it will be well in the future for obstetricians to regard thymus engorgement as a cause for the calamity.

According to Henderson a great many infants are lost at birth and in the two weeks following from atelectasis. Examination of the lungs post mortem often shows areas of improper expansion. Accordingly it is advisable that all the older and cruder methods of resuscitating an asphyxiated infant, such as hot and cold dipping, spanking, slapping and swinging, be abol-

ished. In place of these, reliance should be placed on gentle mouth to mouth breathing and the inhalation of a mixture of 93 per cent oxygen and 7 per cent carbon dioxide, as it has been found that the carbon dioxide is the essential stimulant to respiration. This special mixture is available in the market together with an infant's inhalation apparatus with a gas bag and inflatable mask wherewith the administration is exceedingly simplified.

Henderson is so impressed with the value of this procedure at birth and in the early succeeding days, that like the Crede eye treatment, he claims that it should be made compulsory, that every child whether asphyxiated or not be given the benefit of such a treatment for ten minutes several times a day in the first week of its life.

Postnatal pneumonia will account for a large number of fetal deaths. In premature rupture of the bag of waters the baby is in danger from inspiration of infected liquor amnii, the colon bacillus being the most frequent factor. Infection may similarly occur when the head is born and the mouth rests in close proximity to the anus. It follows accordingly that no vaginal examinations should be made in cases with premature rupture of the bag of waters as the baby is in sufficient danger from the microorganisms that can naturally gain entrance to the uterus if the labor is prolonged without having additional germs implanted by the examining fingers. Furthermore, care should be taken to keep the perineum and the anus free from fecal matter at the expulsive stage of a delivery.

Every hospital should be provided with the oxygen carbohydrate apparatus for resuscitation of asphyxiated infants and for the treatment of atelectasis and pneumonia after birth. It may perhaps be unreasonable at present to expect every practitioner to carry such an apparatus with him in home deliveries. He should, however, always be prepared to give immediate assistance to the asphyxiated and narcotized baby. Nearly all physicians now use some form of analgesia in the

conduct of labor cases and in consequence a differentiation must be made between a narcotized and an asphyxiated baby. The narcotized baby as a general thing is blue and makes no effort to breathe. Fortunately in most of such cases respiration can be induced by the intravenous injection of an ampoule of alpha lobelin. The umbilical cord is the most convenient site for the injection in the baby. The injection should be given into the umbilical vein and the vein can best be recognized by the fact that its course is straighter than that of the umbilical arteries, furthermore the umbilical arteries pulsate. A varicosity of the vein on the outside of the umbilical cord is selected about 4 to 6 inches from the vulva and the alpha lobelin injected with an ordinary hypodermic syringe. This procedure with proper removal of the mucus from the throat, gentle mouth to mouth breathing and keeping the baby warm should prove efficient in most cases of asphyxia and narcosis in the home.

Finally there is the class of cases where the fetus can carry on an intra-uterine existence, with respiration, nutrition, excretion and circulation through the placenta and umbilical cord, but which is absolutely unfitted for postnatal existence on account of abnormalities in development. In such cases the fetal heart will have been heard throughout the delivery and yet an apparently deeply asphyxiated baby will be born, perhaps after an unusually easy labor, that does not respond to efforts at resuscitation. Three cases of that kind occurred in our experience. The one after an easy cesarean section showed an imperforate anus and upon postmortem examination, transposition of all the viscera. The left side of the diaphragm was absent with the heart and lungs crowded to the right and the stomach and small intestines pushed up to the clavicle. The second case was on the same order with the exception of the imperforate anus. The third had congenital cystic kidneys with atresia of the ureters. It follows that in all obscure fetal deaths in uncomplicated

deliveries the physician should demand a postmortem examination or at least the possibility of an abdominal inspection and if such an abnormal condition presents itself then it will be a full exoneration of the attending obstetrician in what would otherwise be a very annoying and disheartening occurrence.

In spite of especial care in the conduct of our cases at the Louisville City Hospital we have to report for the year from July 1930 to July 1931, 138 fetal deaths in 1471 deliveries. Of these fetal deaths only 42 were full term, 96 were premature with 38 non-viable. In addition 31 fetal deaths were due to syphilis.

Fifty per cent of the fetal deaths accordingly were beyond our control. Other public institutions of a similar character no doubt have about the same mortality.

Therefore, while we should make every effort to reduce fetal mortality, yet the profession should no longer subject itself to criticism by the medical and lay press from the constantly repeated statement that 200,000 or more babies are lost each year in childbirth and that we rank seventeenth among the nations on account of our obstetrical mortalities, without explaining that fully 50 per cent of the fetal deaths are due to premature, non-viable, syphilitic, and macerated, fetuses, and other unavoidable fatalities, including a large percentage of abortions, which no amount of obstetrical skill or attention can lessen or prevent.

#### REFERENCES

- MCCORD, J. R. Syphilis of the placenta in the Negro. *Am. J. Obst. & Gynec.*, 11: 850, 1926.  
 STRACHAN, G. I. Placental changes in relation to fetal death. *Brit. M. J.*, 2: 594, 1922.  
 GAMMELTOFT. Syphilis in pregnancy. *Am. J. Obst. & Gynec.*, 15: 747, 1928.  
 GOODMAN, J. The thymus gland in the newborn. *Trans. Am. Ass. Obst., Gynec., & Abd. Surg.*, 34: 277.  
 BELDING, D. L. Effect of the treatment of the syphilitic pregnant woman upon the incidence of congenital syphilis. *Am. J. Obst. & Gynec.* 12: 839, 1926.  
 HENDERSON, Y. Incomplete dil of lungs as a factor in neonatal mortality. *J. A. M. A.*, 96: 495, 1931.



COMMENTS ON  
TORSION OF THE ADNEXA  
WITH A REPORT OF ILLUSTRATIVE CASES\*

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IN the past six months various interesting cases of adnexal torsion have come to our notice in the University of Chicago Clinics. On account of the supposed rarity of such lesions we have considered them in some detail.

INCIDENCE

It is interesting to notice how the literature has been characterized by groups of reports, as for example, those that followed the papers of Schweitzer and Ruder in German and Davies in English. When attention is called to the possibility of torsion more examples are found. Many cases have been unreported, as Battey mentioned in discussing the paper of Munroe. The same comment was made by Bloomer, Gale, and Rogers. Eastman remarked on the frequency of these cases in a rather small clinic. Anspach reviewed a large number of reported cases in 1912 and remarked that many references had escaped him. Forty-four authors have reported more than one case, of whom the best examples are Lejars with 8 cases, Hammerschlag with 5 cases, Gengenbach with 6 cases, Bass with 11 cases, Michon with 5 cases.

The diagnosis may be difficult and make recognition very hard. Some cases have had absolutely no history of lower abdominal distress (our cases II and V, Haultain's cases I and II, Mauclaire's case and Siredey's case). The distress may be very trivial (Michon, case V). There may be only a mild dysmenorrhea whose distinctive characters, if any, are overlooked (Gueillette, Gabe, Auvray case II, Pozzi case III, Fuchs, Tourneaux cases I and

II). The torsion may be very temporary and so the attack of pain be very brief. Some surgeons have found the torsion uncoiling spontaneously (Wachtel case II, McIlroy, Miles). Rogers found a pair of twisted tubes of which one was in such good condition that it could be untwisted and left in situ. Some cases are found only at autopsy accidentally, as in our Case II and many of the earlier cases reported, e.g., Morgagni, von Rokitansky, etc. The latter alone found fifteen such lesions at autopsy.

On the other hand a typical distress may develop, last only a few hours, and then disappear for hours to years (Stark, Michon case V, Laurent, Kohler, Schreiner, Chabrut, Fuchs, Roll, Cassidy and Norbury). Well over one-third of the patients have had symptoms of some sort for a considerable time. The attacks may go on as long as nine years (Martin), or eight years (Michon case I). Anspach, in his collected cases, 87 in number, observed that 56 had had symptoms for two weeks or more, but 9 for thirty-six hours or less.

Probably many cases have been missed even at laparotomy. For example, Aulhorn's case and Gengenbach's case IV both suggested ectopic pregnancy at first sight. Hematosalpinges, ovarian infarcts, hemorrhagic ovarian cysts or ovarian pregnancies are very difficult to differentiate largely because torsion is so often followed by the formation of hemorrhagic or infarcted tissue. Many operators have used right sided incisions and have, therefore, explored the adnexa by touch rather than sight. This would prevent the diagnosis of slight degrees of torsion at least

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(Darner). In many clinics insufficient study of the operative specimens has been responsible for missing these lesions.

It seems difficult, therefore, to estimate the real frequency of adnexal torsion, but it probably is much commoner than has been supposed. The torsion of ovarian cysts, as in our case v, is extremely common; Martin estimated 5 per cent of ovarian cysts twisted and Kustner 47 per cent; but perfectly normal adnexa may undergo torsion and probably often do. Moreover such etiological factors as are discussed in this paper are so frequent and the symptomatology of these lesions so variable that it is doubtful if we diagnose more than a few of the actual cases.

#### CHARACTER OF TORSION

The degree of torsion seems to have very little clinical significance as Michon observed in his first three cases (Haultain, Norris, Stein, Paucot and Meurisse, Wachtel). Haultain's case III had symptoms for four years which may or may not have been due to torsion but which, however, suddenly became extremely acute. At operation the left tube and ovary were found twisted only two-thirds of one turn. Many cases have undoubtedly had many turns for years without symptoms, as already mentioned. Some of these have had one more suddenly added to produce the characteristic group of symptoms the others had failed to excite (Bell, Grosse). Possibly the factor producing pain is not torsion at all but rather a hemorrhage into the muscle wall especially under the serosa (Ogorek, Michon). The presence of hemorrhage or infarction usually dominates the picture in cases where pain has been a symptom. We can see how the circulation in a loosely twisted mesosalpinx or ovarian ligament may be competent till a minimal additional torsion will produce widespread congestion with rupture of the vessels and the sudden characteristic onset of pain due to hemorrhage.

Considerable attention has been given to the direction of the torsion. Schauta be-

lieved that right-sided pedunculated bodies twist to the right and left-sided bodies to the left when torsion occurs. The data in many of the earlier reports, especially, is incomplete in this regard. There has been a very loose terminology also (see Küstner, Lippert, and Schauta's comment on Küstner) and obvious misuse even of such terms as clockwise and counterclockwise. But assuming that the plane of reference is the mid-plane of the body and that the observer is looking outward along the tubes toward the ovaries in orienting these torsions, we have tabulated all the reports of otherwise normal adnexa found. By normal adnexa we mean the few where histological examination demonstrated normality and some cases in addition where there was a balance of evidence for normality, e.g., a history of several normal pregnancies. We found that there had been torsion of the right tube 60 times and of the left 28; of the right-sided torsions 7 out of 15 were clockwise, in the left, 6 out of 12 were clockwise. On the same basis the number of normal ovaries reported with torsion is 35, 15 on the right and 10 on the left. Apart from Smith's and Butler's report on ovarian torsion only one mention is made of the direction of the twist (Wachtel). Smith and Butler, however, found that Küstner's law as interpreted by Schauta, and by Downer and Brines, usually held. It seems to us that the general validity of Küstner's law is very doubtful for the adnexa, certainly as far as tubes are concerned. There is, of course, a very obvious preponderance of right-sided torsions as will be discussed later.

#### LATERALIZATION

As already mentioned the ratio of right to left sided torsions of normal or probably normal tubes is 60:28, of ovaries 15:10. This is very close to the figures given by Anspach, etc. for unselected groups. The presence of the sigmoid wedging the contents of the left pelvis in place, the peristalsis of the small

bowel on the right (Woollcombe) and the presence of the adjacent appendix (Thorek) have been used to explain this right-sided predominance. A great many of these specimens are secured at operations aimed at the appendix. Symptoms which in the right lower abdomen would frighten a surgeon into immediate operation seem much less alarming when on the left; hence, the latter are treated conservatively, subside, and are often undiagnosed. Moreover, should operation be done the left adnexa are too far away from right-sided incisions to receive satisfactory attention. These things may be real factors in the reported incidence.

More important in this right-sided incidence may be the predominance of right-sided use of our bodies. We use our right limbs oftener and more violently. Our right shoulders droop and when we lift we compress the abdomen more on the right because more weight is born by the stronger muscles. Objects we hold are usually steadied by pressure against the right abdomen. Zikmand (see Horsch) made the interesting observation that in 1913 only 13 per cent of ovarian tumors were twisted as against 25 per cent in a similar series collected in 1916, and he ascribed this largely to the increased muscular activity of heavy war work. Tenckhoff (*loc. cit.*) ascribed the torsions largely to symmetrical pelvic motions: Spasmodic acts such as laughing, sneezing, etc. may be factors in causation but not in lateralization. Schreiner had a patient whose first attack occurred while carrying a two-year old child, and the second attack a year later while scrubbing clothes. It is to be noted that the tendency to right lateralization is more marked for ovaries than tubes probably because the latter are closer to the midline and on movement have a smaller arc and acquire less acceleration.

#### SPONTANEOUS AMPUTATIONS

In 1914 Ogorek collected 97 cases of spontaneous adnexal amputation, of which

27 were discovered at autopsy and 73 were complete. The autopsy cases began with Morgagni in 1748 and ended with von Baumgarten in 1892. There have been 24 cases of complete or incomplete spontaneous amputation reported since Ogorek's papers appeared, bringing the total number in the literature up to 122. Ours is the 123rd. The cases added have been those of Schweitzer, Hirsch, Robinson, Cotte, Grosse, Bass, Gengenbach, Michon, Spencer, Michon and Comte, Küstner. In only half of these was the amputation complete. Of the complete amputations 8 involved the right adnexa and 8 the left. The accidents were generally ascribed to tubal torsion.

The amputated portions may be one or several organs. The site may show no scarring as in the case of Michon and Comte and our case 11, or may show definite scars as in Michon's cases 1 and 11. Braun had a case of unilateral torsion of the adnexa in which no trace of scarring could be found one year later (see Menge and Oettingen). Only the demonstration of the interstitial part of the tube proved what had happened.

Such accidents may be symptomless. The amputation may end with calcification of the amputated portion or degeneration and complete resorption. As no trace of tube was found in our case it was probably completely resorbed. Amputation may be bilateral (Michon and Comte, Ries, Albertin). The cases of Michon and Comte, and Albertin were only recognized on careful examination of the specimen although the amputation was complete. Intra-uterine torsion and torsion in the first week of life were reported by von Rokitsansky and von Heschl, von Rokitsansky and Fraenkel (see Ogorek).

There may be no pain or there may be sharp and sudden pain. The pain may subside for years only to recur and subside as before (Ogorek, case 11); there may be severe dysmenorrhea for as long as ten years although the lesion seems healed at operation (Michon, case 1).

The diagnosis is from congenital anomalies, ruptured ectopic pregnancy or gumma. Congenital defects are usually accompanied by genitourinary anomalies or uterine malformations. A good survey of the subject is given by Menge and Oettingen, also by Michon.

#### TORSION OF NORMAL ADNEXA

Anspach and Thorek have cast doubt on the authenticity of such lesions. They remark that childhood exanthemata may produce chronic involvement of the internal genitalia and that early vulvovaginitis may persist for years. It is difficult to combat this point of view as histological findings after operation are confused by the aseptic inflammation attendant on torsion as well as the massive hemorrhage which destroys or masks the tissue structures. Many authors have reported hematosalpinges as normal tubes, assuming they could differentiate primary from secondary hematosalpinges. Anspach cites the cases of Funke and Hennig of tubal lesions in virgins after "typhus," and Almartine's torsion of the tube in a tuberculous virgin. A lesion may be in an incipient stage and so not be diagnosed at operation. For instance, Anspach operated on a right pyosalpinx and re-operated on the same patient two years later, only to find a tuberculous salpingitis on the opposite side. A tube may seem to be quite normal, free of adhesions and patent, but be tuberculous on microscopic study (Gery and Lacoix). Few authors have studied their tissues histologically and so the judgment of the remainder may be faulty. But in those cases in which we have a recognizable tissue for examination soon after torsion occurs and can find in it no evidence of acute or chronic inflammation, we may assume the tissue normal. Any other attitude is hypocritical.

We have found fairly good evidence that the tubes involved were normal in 53 cases reported. About half of these have no microscopic reports; some were removed during gestation and were con-

gested, etc. But we have excluded only those cases where there was some reason to suspect infection or the interference of adjacent masses. These reports begin with Stark and Schweitzer and end with the recent ones of Michon, Walawelski, Cotte and Gengenbach. This excludes cases of spontaneous amputation simply because so many of these showed too much degeneration to estimate if normal conditions preceded the accident. We also found about five reports of the torsion of normal ovaries since Smith and Butler collected their cases in 1921. (Of course, many of their cases were not normal by the criteria mentioned above.) Our own case iv should be added here. Many of these so-called normal adnexal torsions gave histories of prolonged and characteristic symptoms and on histological study might very well have shown tissue changes which would have precluded their inclusion on this list.

#### ETIOLOGY

This is a vexed problem. The usual long list of traumatic causes have been adduced. No experimental work has been done except the indirect studies of Payr and Sellheim.

Probably the foundation is laid in fetal life. The presence of tightly coiled spirals in fetal tubes and infant tubes is common knowledge. Spuler remarked that as the body of the fetus grows the tubes stretch and later elongate. The ovaries, however, come closer to the fundus uteri. As the tube is considerably longer than the overlying peritoneum, it assumes convolutions or spirals. The discrepancy between the tube and its overlying peritoneum persists to about puberty at least and is common even in adults. Auvrey believes that actual fetal spirals may persist. Vigholt quotes Hess as saying that 30 per cent of adult tubes show infantile characteristics. In a series of 25 autopsies on female infants, done during the course of this study, all of them from six months gestational age to two years, we found 7 cases of complete single or double spiral twists of one or both tubes. In 4 cases the right tube was

involved, in 3 cases the left. In all of the latter the spiral was contra-clockwise; in the 3 right-sided cases in which it was recorded it was twice clockwise and once contra-clockwise. These figures are somewhat suggestive.

Probably these spirals develop in fetal life if the ovary's descent is very rapid or the tubal portions unusually elongated or elastic. Most twisted tubes reported in both fetuses and adults have been disproportionately long. The corpus uteri is markedly anteflexed in the young fetus. This anteflexion throws the anterior half of the first coil of the tube forward and so gives the initial impetus to contra-clockwise coiling on the left and clockwise on the right side. This tendency persists in succeeding coils since it is so difficult to reverse the direction of any spiral once it is under way. In 2 of our cases, including the illustrated one, there was a marked anterior rotation of the corpus uteri on the same side as the twisted tube. Fuchs reported a case of twisted hematosalpinx which he ascribed to congenital convolution of the tube producing obstructions and later aseptic inflammatory obstruction. Spuler remarks that the tubal ostia are often closed in the newborn; that as early as the 30 mm. embryo we can see swelling of the fimbriae and these may close the ostium in late fetal life or in the newborn. There may be the same tendency in the plicae of the tube, producing the diverticula, and pockets in the mucosa that are found in adults.

Many torsions have been reported before puberty (Neugebauer, Wachtel, Munroe, Roll, Fiolle, Downer and Brines). Roll's cases were in two sisters, aged seven and one-half and eight years respectively. There have been cases of tubal torsions after the menopause (Gengenbach, Borner, Grossman). These last 3 cases were in abnormal tubes, however.

The relation of trauma to these incidents seems very definite. All trauma applied to a pelvic organ is tangential and so has a twisting moment (McIlroy and Bass).

Often the symptoms begin immediately after an unaccustomed trauma. For example, reports are to be found of torsion following carrying a child, scrubbing clothes (Schreiner), shoving a stalled car, and lifting (Kohler), sports (Rogers, Ruder and Hansen), a kick in the belly (Darner), washing (Borner, Ogorek), sweeping (Norris), stooping (Dearborn). Anspach reported such causative trauma as sitting down too hard, suddenly rising from a seat, falling on the street, a long walk, riding in a street car, cranking an automobile, and defecation. Zikmand (Horsch) made the interesting statistical observation previously mentioned. Sellheim actually produced torsions in bed-patients (in one case of  $3\frac{1}{2}$  turns) in 2 cases which had ovarian cysts, by rotating them and suddenly stopping the rotatory motion.

On the other hand many cases have come on suddenly out of a clear sky; in some of these no trauma could possibly have been causative. Martin's patient had her first attack in the middle of the night. Bass' case I was of a woman three months pregnant whose first attack came on suddenly in the night. Corlette's patient had been in a hospital bed twenty days when the pain suddenly began. Michon's case v recurred suddenly at night after a two-year period of freedom.

Unusual laxity of the supporting ligaments and unusual length of the viscera themselves have been considered an important factor by a great many authors. None of our cases had this characteristic, and we think it is of very secondary importance. If a tube or ovary is about to twist, it will twist whether or not it must first turn the whole broad ligament or adjacent adnexa. Ogorek cites instances of tubes as long as 36 to 76 cm. Bittman found that the opposite tube was very long and the twisted one very infantile (which was probably much more to the point). Vigholt remarks that in one case reported the mesosalpinx on the side affected was four times as long as its mate opposite. An abnormally long supporting

ligament prevents replacement when torsion occurs (Douglass). Muir's case occurred (after dancing) in a woman who had had an unrepaired prolapse of eighteen years' duration.

Another debatable etiological factor is inflammation. J. L. Faure in discussing the paper of Rocher and Jeanneney remarked that a pliable normal tube should twist more easily than a thickened inflamed one. Anspach believed that adhesions were conservative measures and yet reported a case of torsion of a tube containing pus and showing adhesions. Bloomer, Gale, Miles, Gabe, Bell held that adhesions were definitely a conservative measure. Michon suggested, however, that adhesions were etiological factors. Pozzi's case I showed no appendix but the site of the appendix on the cecum was adherent to the twisted right adnexa. His case II showed some pus on the right side of the pelvis at the time of an operation for right ovarian torsion. Thirteen days later re-operation showed free pus in the pelvis and torsion of left adnexa. Both excised tubes showed similar lesions. Sellheim, in discussing Hornung's paper, emphasized the ability of the blood stream to untangle a torsion that has just occurred unless a strong force maintained the displacement.

Tenckhoff (see Horsch) emphasized that in symmetrical movements of the pelvis the organs tend to lag a little behind the pelvic rotation. Friction of the belly wall tends to prevent torsion. The thinner the fluid content of an organ, the more independent it is of movements impressed on it by its enclosing wall, and hence torsion occurs more readily. The freer the swing and the larger the mass the greater is the arc described. By experiments with raw and partially cooked eggs, with the fetus in an intact amniotic sac, and on patients with ovarian cysts, he showed how the sudden stoppage of rotatory movement caused torsion.

Haim, Michael and Guibal, Gengenbach, Mandelstamm, Bass have reported cases of torsion in the puerperium. If laxity of

supporting structures were important, accidents of this sort should be common. Moreover, changes in intraabdominal pressure should then be most rapid and most marked. Some twenty-one authors have reported cases of torsion during pregnancy. There are 5 cases reported of torsion of tubal pregnancies, viz. LeBalle, Charbonnel and Favreau, Pozzi case III, Martin, and Freund Jr. (for latter two see Littauer). LeBalle reported a tubal abortion on one side with a twisted pyosalpinx on the other.

It is very significant to observe the relation of torsion to the menses. Of course, cases have occurred in children before puberty, and in 3 cases in the menopause (see foregoing). But the great majority of the cases are strikingly related to menses. For example, some 21 reports since 1900 have commented on this characteristic. Notable among these are the cases of Grossman, Davies, Rogers, Allen, Darner, Miles, Terruhn, Torland, Casagrande, Vigholt, Gueillette, Gabe, Hammerschlag, Walawelski, Auvray cases I and II, Pozzi cases I and III, Morel, Norris, Fuchs, Tourneaux, Michael, Wells, Holtmann, Michon, our own cases III and IV. There seems no doubt that this accident tends to occur at or near menstruation. Chaput reports 2 unusual cases of young women who had had no menses and so had in the course of years developed hematocolpos and hemato-peritoneum. Both had imperforate hymens. These were ruptured and the patients each died in a few days in coma. At autopsy the tubes were found enormously enlarged and in each case one tube showed torsion.

The importance of tubal peristalsis was expressed by Mauclair. Cahen found the contractions of tubes in animals were short and regular in the dioestrus, but strong and slow after oestrus. He quotes Keye who puts the augmentation of uterine contractility at about the tenth day after dehiscence. Hartman found increased motility during the migration of the ovule. Seckinger and Snyder found in portions of

excised tube muscle that there was an increase in the rate and size of the contractions in the premenstrual phase and that the rate was even more rapid in the early interval stage. Kok quotes Thorn who noted the expulsion of tubal pregnancies by painful peristalsis and anti-peristalsis. Mickulicz-Radecki remarked that the motility of the human tube varied greatly. He saw very strong contractions with contraction intervals up to five minutes in length in a tube removed on the second day of a period and three tubes of ruptured tubal abortion; these were especially strong in the tubal abortion. The maximum shortening was 2 cm. (in a 12 cm. tube). A tube on the first day of a period showed very poor contractions and the same was true of two badly damaged tubes from tubal abortions. Almost all the tubes contracted in a similar rhythm, about fifteen to forty-five seconds at a time. No difference was found for tubes taken in the interval days, during pregnancy, or in senility. Where there was fresh inflammation or in atrophic or anemic tubes there were no, or scarcely any, spontaneous contractions. The intensive contractions at menses or in tubal abortions were explainable by the increased size of the tubal content acting as a foreign body as it would in the gut. Darner quotes a personal communication from Guttenmacher who found violent and irregular contractions in the tubes of the pig before sex maturity.

Certain individuals, perhaps a very high percentage, have some persistence of the long thin-walled infantile type of convoluted tube. Spirals in such tubes are relatively frequent. In early life the inherent motility of smooth muscle begins to display itself and probably increases toward puberty. Thereafter it is strongly accentuated before and especially just after menstrual periods; it also persists after the menopause. This motility is increased by mild inflammations locally, by congestions or traumata producing aseptic inflammation, and by menstrual

congestion. However, if the inflammation progresses to the stage where the tubal muscle or blood supply is injured there is a marked decrease of peristalsis and anti-peristalsis. The early formation of adhesions is a complicating factor, for this induces stasis, local infarctions, and thromboses, all of which are elements of a vicious circle and tend to maintain the viscus in its new locus. Until such adhesions form, the force of the blood stream largely serves to right any malpositions that develop. At the same time perhaps there are obstructions in the tubal lumen. These may be due to a persistence of fetal agglutination of fimbriae or plicae, or to the regurgitation and exaxial lodgement of clot or endometrial fragments from the corpus uteri. Whatever the obstruction, there is a corresponding increase of tubal peristalsis. The peristaltic waves must now travel over a muscle wall of varying conductivity and contractile power. This variation is probably due to inflammations or to congenital distortion as already mentioned. In any case, the irregular front of the advancing peristaltic wave coming to a point of obstruction creates a twisting moment about the tubal axis. This is very well demonstrated in tubal ectopics such as we have cited. In them the increased motility of both tubes which results may produce a torsion of the unimpregnated tube and this may occur even in spite of factors producing adhesions such as acute inflammation, free pus and blood in the pelvis. Even if the walls of the tubes are materially damaged by enormous distention one may still have torsion produced as soon as peristaltic activity has an opportunity to empty them. Küstner's law does not seem to apply to normal or relatively normal tubes.

Contributing factors in adnexal torsion are unusual length of the structures involved or their supporting ligaments, a thin or infantile type of pedicle in the organ itself and some exciting external trauma. As these latter factors are largely right-sided in a right-sided species, the

greater proportion of these lesions are found on the right side of the pelvis. All external trauma applied to smooth-walled viscera is tangential and so has a twisting moment.

These traumatic and architectural features are much more important in organs like the ovary which are comparatively free and distinctly lateralized. These have a correspondingly greater tendency to right-sided incidence. They show more tendency to follow Küstner's law because their tissue is denser and has a specific gravity sufficiently great to admit the play of gravity, something a hollow tube scarcely allows. Moreover, cysts of some sort or other are so frequent in the ovary that Sellheim's mechanism becomes applicable and the fluid contents of these cysts explains much of what happens. Payr's mechanism has something to contribute to torsions in any of the adnexa but, of course, merely initiates changes. Payr himself could under the most favorable conditions in isolated organs produce only 180 degrees torsion by its means. However, it may retain an organ in an abnormal situation long enough for other factors, such as light adhesions, thromboses, etc., to maintain and increase the torsion already begun.

Laxity of ligaments and pedicles cannot be accorded very much importance, or puerperal torsions would be the rule rather than the exception. Probably the adnexa involute at least as rapidly as the corpus uteri and hence are not loose but fairly taut throughout the puerperal period. Torsions during pregnancy may be due to fetal movements, displaced gut, etc., but are, on the whole, inhibited by the enlarged uterus which occupies most of the available space in the pelvis, and keeps the adnexa fairly taut.

It seems likely that inflammation plays a double role, inciting torsion by increased peristaltic activity and obstructions, maintaining any torsions that occur, favoring congestions, thrombosis and stasis. But when acute and severe it damages the tube so badly that tubal motility is im-

paired and adhesions are rapidly formed to maintain the viscera in situ. In passing we might note that Chaput and others have had cases of tubal torsion where both ends of the tubes were fixed by adhesions. These are difficult to explain.

#### SYMPTOMS

This topic has been well discussed recently in English by both Darner and Koster. The symptoms range all the way from those of mild dysmenorrhea to those of an acute abdominal emergency, with vomiting, intestinal obstruction and such agonizing pain as only morphia can control. There is often a history of recurrent attacks, usually with a definite relation to menses, and dating back to an important abdominal trauma or rhythmic movement. If right-sided the case presents features very like those of appendicitis but rectovaginal examination will usually determine the true nature of the situation and if the case is held over the symptoms rapidly subside. Occasionally leucocytosis and fever occur, but this is rare. Two of our cases showed considerable dyspareunia.

#### DIFFERENTIAL DIAGNOSIS

This also has been well discussed by the last named authors and very many others. The principal differentiations are from appendicitis and ectopic pregnancies. Nearly all the early cases were operated on for appendicitis. When mistakes have been made they have usually been directly traceable to the omission of rectovaginal examination. The characteristic history of a sudden onset after trauma, recurrent attacks related to menses or traumata, and the tendency to complete temporary bowel obstruction are great helps to diagnosis.

#### TREATMENT AND PROGNOSIS

It has been generally held that the proper treatment for cases of adnexal torsion was immediate laparotomy, or laparotomy as soon as possible after the acute phase was over. It has been shown repeatedly that if the diagnosis has been



made to one's satisfaction it is safe to let the patient alone for weeks or even a month or more until the tenderness, pain

acknowledge Prof. Adair's accustomed courtesy in assisting with the preparation of this report.

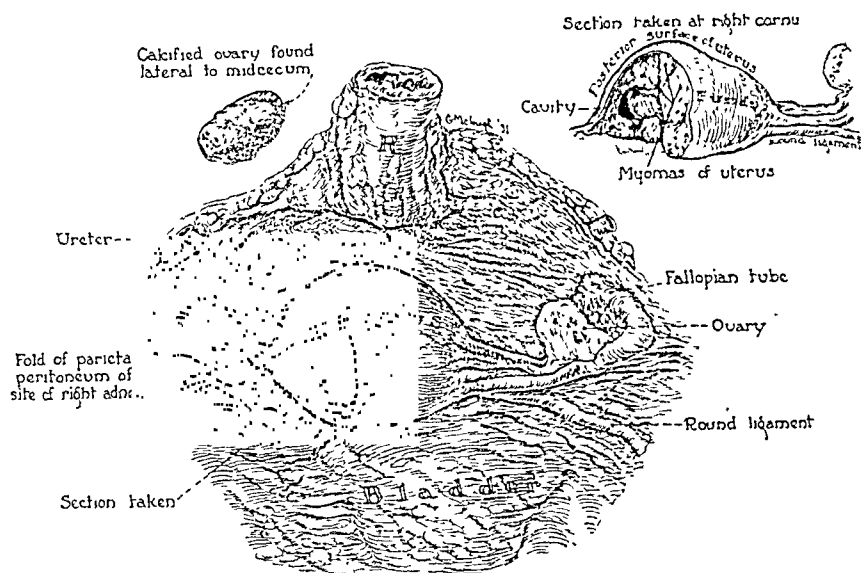


FIG. 1. Case 11. Spontaneous amputation of right adnexa in an adult. One insert shows amputated ovary and other shows a section through fundus uteri at right cornu.

and fever have reached a minimum. If one is uncertain about the differential diagnosis no harm is done by immediate intervention. If no such intervention occurs the body can handle the situation fairly well, but symptoms of discomfort of varying degrees with periodic recurrences continue for years, and in the end most of such cases necessitate operation anyhow. Where such cases are left alone spontaneous amputation and resorption occur, or progressive torsion develops with eventually even gangrene, or dense protective adhesions ensue which wall off the lesion. On the other hand, as mentioned in the foregoing discussion, the torsions may untwist and it is very probable that many transient pelvic pains are produced in just this way and never are diagnosed, much less come to the operating table. We would like to emphasize that this possibility should always be borne in mind in abdominal diagnosis.

We must thank Dr. F. L. Adair for permission to publish cases I, IV, V and VI, and Dr. H. G. Wells for the same privilege in cases 11 and 111. It is a pleasure to

#### CASE I. Miss G. H., No. 21731. Age 41.

Three years before admission the patient noticed a soft moveable mass in the lower abdomen. This had doubled in size since it was first noticed. She suddenly developed lower abdominal pain on April 10 and the following night the pain was excruciating. When examined on the fifth day of the attack there was a midline mass in the abdomen the size of a grape fruit and movable. A little to the left was another mass firmer in consistency. The last menstrual period had ended seven days before the attack began; the periods of the last five months had been irregular. The preoperative diagnosis was a fibroid on the anterior left side of the uterus and a right pedunculated ovarian cyst. There was a slight fever; and the white blood cells were 10,000 on admission.

At operation on April 18 the left adnexa were found normal. On the right there seemed to be a gangrenous ovarian cyst with two complete twists involving tube and ovary. No adhesions were seen.

A careful study of the excised specimen showed that the cyst was a large parovarian cyst, 10 cm. in diameter. The right tube was adherent to it and stretched over it in such a way that its distal end was immediately

adjacent to the uterine cornu; some of the fimbriae, indeed, had separated from the ostium and attached themselves to the isthmic portion of the tube. At its distal end this tube was closely adherent to the ovary and both were twisted clockwise through 360 degrees. The ovary was enlarged to twice the usual size and contained a large red infarct. The parovarian cyst contained a thin bloody fluid. The tube was distended with blood.

Microscopically the cyst wall was semi-necrotic. The ovary showed a large hemorrhagic infarct. There was no trace of inflammation nor evidence of old scarring. The tube was congested and necrotic.

CASE II. Mrs. M. C., No. 10309. Aged seventy-one. (Fig. 1.)

The patient had had one normal full term delivery fifty years ago and no other pregnancies. For years she had attacks of cholecystitis. There had been no attacks of dysmenorrhea. There had been nothing unusual during or about the time of the pregnancy and no abdominal operations. She was first seen in the University of Chicago Clinics in 1929, nineteen years after her menopause and at that time was found to have a hypertension with marked arteriosclerosis, pernicious anemia, and persistent constipation.

Death occurred from cerebral thrombosis. At autopsy the right adnexa were not found and there was no scarring at the site of amputation. The uterus was symmetrical but as there were several intramural myomata this was not very significant. There was not even a stump at the right uterine cornu. There was, however, a small calcified body, the size and shape of the normal left ovary, adherent to the parietal abdominal wall just lateral to the cecum.

On microscopic study no trace of the tube or round ligament was found in the broad ligament. The right cornu of the uterus, however, showed clearly a residue of the interstitial portion of the tube. The small body beside the cecum was sufficiently calcified peripherally to mask all the cortical structures. The general structure strongly suggested ovary, however, with tiny cysts toward the periphery and central ossification.

CASE III. Mrs. G. O., No. 29045. Aged forty-seven.

This patient died from carcinoma of the stomach. Her previous illness had been typhoid

and pleurisy. There had been six children and three miscarriages. She was still menstruating without abnormality or pain. There had been a

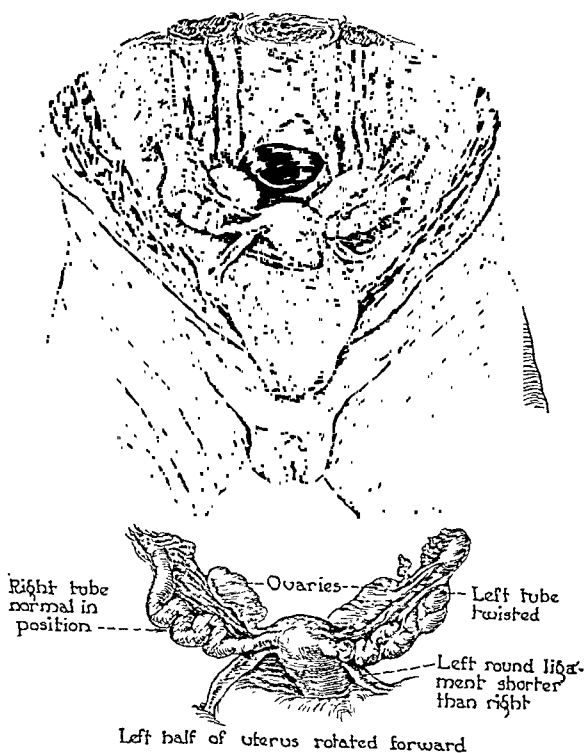


FIG. 2. Case vi. Pelvis of fetus 42 cm. long, showing spirals in left tube. Insert shows internal genitalia magnified.

pelvic repair and appendectomy fifteen years before. In 1923 there had been a six months period of pre-menstrual pain, which was bilateral and excessive, with marked dyspareunia.

The autopsy disclosed an anterior displacement of the left round ligament, with corresponding broadening of the superior part of the broad ligament. The left tube was slightly enlarged and hidden in a groove formed by the anterior rotation of the left ovary and its utero-ovarian ligament. The distal extremity of this tube was densely adherent to the sigmoid. The ovary was adherent to the broad ligament, and the adjacent tube. The ovary appeared normal, as did the right adnexa. The left tube was thickened and obstructed. The direction of the ovarian torsion was clockwise.

Microscopically there was no evidence of inflammation in the ovary but there was a well marked chronic salpingitis.

CASE IV. Mrs. M. P., No. 27310. Aged forty-two.

This patient had had mumps in childhood. There had been one pregnancy, and an appen-

dectomy thirteen years before, but no history of trauma. For the last five years she had had tremendous premenstrual dysmenorrhea lasting one to two hours and always appearing about eight to nine hours before the flow began. This pain was not lateralized but was severe. There had been marked dyspareunia for the last three years. She came to the University of Chicago Clinics for metrorrhagia and menorrhagia. The uterus was found to be considerably enlarged. At operation the left tube was found dilated distally and the left tube and ovary twisted at least 180 degrees contra-clockwise. There were some adjacent adhesions. The right adnexa were negative.

On detailed examination of the specimen it was seen that torsion of the tube amounted to 140 degrees and that the ovary had undergone an additional 40 degrees or more of torsion in the same direction. The distal half of the tube was enlarged to three times normal size and was congested. There was ecchymosis in the portion of the mesosalpinx adjacent to the ovary. The uterus showed multiple fibromyomata.

Microscopically the ovary and tube showed edema but no marked congestion. There was some thickening of the tubal plicae but no evidence of infection.

CASE V. Mrs. B. W., No. 32760. Aged eighty-one.

The patient had an uneventful menstrual history, with menopause at the age of forty-four. There had been eight pregnancies and normal deliveries. She came to the University of Chicago Clinics complaining of abdominal swelling of four months' duration with some gain in weight. This was very obviously due to a large ovarian cyst reaching almost to the xiphoid. On operation this was found to be connected with the left ovary and there was a complete contra-clockwise torsion of its pedicle. The other ovary was slightly cystic. On closer examination this was found to be a simple left monolocular cyst, free of adhesions and with no change in the adjacent tube. There were numerous coalescing fibromyomata in what remained of the left ovary.

Microscopically the tube was atrophic and the cyst wall showed nothing of interest.

CASE VI. Baby Becker, 42 cm. long. (Fig. 2.)

This premature, well-developed fetus had a markedly anteflexed uterus rotated 30 degrees anteriorly on the left. The left round ligament was correspondingly short and taut. The right tube was much convoluted. The left tube had a spiral near the cornu as well as farther out. Each was one complete turn and contra-clockwise.

#### BIBLIOGRAPHY

- ALLEN, R. M. *M. J. Australia*, 2: 227, 1925.  
 AHUMADA, J., and PRESTINE, O. *Abst. in Zentralbl. f. Gynaek.*, 53: 3175, 1929.  
 ANSPACH, B. M. *Am. J. Obst.*, 66: 553, 1912.  
 AULHORN. *Zentralbl. f. Gynaek.*, 34: No. 16, 538.  
 AUVRAY, M. *Arch. mens. d'obst. et de gynec.*, 4: 97, 1913.  
*Ibid.* 2: 1, 1912.  
 BARONI, L. *Abst. in Zentralbl. f. Gynaek.*, 53: 3175, 1929.  
 BASS, F. *Zentralbl. f. Gynaek.*, 53: No. 25, 1572, 1929.  
 BECKER, H. *Zentralbl. f. Gynaek.*, 46: No. 50, 2019, 1922.  
 BELL, J. *Obst. & Gyn. Brit. Emp.*, 5: 514, 1904.  
 BITTMAN. *Abst. in Zentralbl. f. Gynaek.*, 46: No. 21, 871, 1922.  
 BLOOMER, G. T. *J. A. M. A.*, 78: 280, 1922.  
 BORNER, R. *Ztschr. f. Geburts. u. Gynaek.*, 97: 93, 1930.  
 CAHEN, J. *Arch. internat. de Med. experimentale*, 4: 7, 1928.  
 CARAVEN, M. *Bull. et mem. Soc. nat. de Chir.*, 53: 550, 1927.  
 CASAGRANDE, J. *Am. J. Obst. & Gynec.*, 15: 49, 1928.  
 CASSIDY, M. A., and NORBURY, L. E. C. *Lancet*, 180: 98, 1911.  
 CHABRUT, R. *Bull. Soc. d'obst. et de gynec.*, 18: 274, 1929.  
 CHARBONNEL and FAVREAU. *Bull. Soc. d'obst. et de gynec.*, 18: 209, 1929.  
 CHAPUT, M. *Rev. de gyn. et de chir. abd.*, 10: 963, 1906.  
 COHEN, M. J. *A. M. A.*, 80: 382, 1923.  
 COTTE, G. *Lyon chir.*, 27: 358, 1930.  
 CORLETTE, C. E. *M. J. Australia*, 2: 719, 1927.  
 DARNER, H. L. *Am. J. Obst. & Gynec.*, 11: 368, 1926.  
 DAVIES, B. J. *Brit. M. J.*, 1: 657, 1925.  
 DEARBORN, S. S. *Bost. M. & S. J.*, 184: 12, 1921.  
 DEBRAY, Ann. *d'anat. path.*, 6: 1255, 1929.  
 DOUGLASS, M. *Am. J. Obst. & Gynec.*, 16: 210, 1928.  
 DOWNER, I. G. and BRINES, O. A. *Am. J. Obst. & Gynec.*, 21: 665, 1931.  
 DUJARIER, C. *Bull. Soc. d'obst. de Paris*, 50: 360, 1924.  
 EASTMAN, N. J. *Surg., Gynec. Obst.*, 45: 143, 1927.  
 EUNIKE, K. W. *Zentralbl. f. Gynaek.*, 46: 1484, 1922.  
 FIOLE, M. J. *Bull. et mem. Soc. nat. de chir.*, 53: 1238, 1927.  
 FRUINSCHOLZ and HAMANT. *Bull. Soc. d'obst. et de gynec.*, 17: 160, 1928.  
 FUCHS. *Monatschr. f. Geburts. u. Gynaek.*, 37: 220, 1913.  
 GABE, W. E. *Arch. Surg.*, 18: 1304, 1929.  
 GALE, W. E. *J. Indiana M. A.*, 19: 98, 1926.  
 GENGEBACH, A. *Ztschr. f. Geburts. u. Gynaek.*, 97: 476, 1930.  
 GERY and LACROIX. *Bull. et mem. Soc. nat. de chir.*, 53: 558, 1927.  
 GILLIES, J. C. *Brit. M. J.*, 1: 187, 1926.  
 GREEN-ARMYTAGE, V. B. *J. Obst. & Gyn. Brit. Emp.*, 31: 87, 1929.  
 GROSSE, A. *Rev. Franc. de gynec. et d'obst.*, 18: 534, 1923.  
 GROSSMAN, H. *Zentralbl. f. Gynaek.*, 49: 1001, 1925.  
 [Bibliography continued on p. 521.]

# TREATMENT OF HERNIA

WITH SPECIAL REFERENCE TO THE INJECTION METHOD\*

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THERE is little to be found relative to the treatment of herniae in ancient literature. In Cruden's Concordance<sup>1</sup> the word Hernia does not appear and in the Iliad and Odyssey<sup>2</sup> no mention of it is made. Just what the ancients did with patients suffering from this condition is not clear but given their ingenuity they certainly must have found some satisfactory treatment to prevent complications of this common condition. We must suppose that crude trusses were used from the very earliest times but accounts of this are meager. There are obscure references to the surgical treatment of inguinal hernia in early medical literature but definite attempts at operative treatment date back to Guy de Chauliac (1300-1370), while the attempt to cure ruptures by injecting irritating solutions in the neighborhood of the sac was not practiced until Velpeau in 1835. The technique was improved by Pancoast in this country in 1844 and in 1877 Schwalbe in Germany advocated injection of alcohol for the same purpose. Heaton (1877), Janney (1880), Warren (1881), Lannelongue (1901), and Manly (1893) made further contributions. At that time the standardization of the operative treatment of ruptures based on the transplantation of the cord as practiced by Bassini and improved aseptic technique became so satisfactory that the injection treatment was all but discarded and in modern textbooks the method is not even mentioned.

As a result of the work of Pina Mestre in Spain and Mayer in this country and others, interest in this method of treatment is being revived and gratifying results are being reported in a large number of cases.

The injection treatment of hernia aims to supplement rather than displace the operative treatment. The injection method is strictly limited to reducible herniae and it is absolutely contraindicated in sacs containing parts of abdominal viscera.

The aim of the injection treatment is to provoke an inflammatory mass in the subcutaneous tissues near the opening in the abdominal wall that will close the aperture very much as a cork stops a bottle. The mechanics of the procedure are not essentially different from that of a truss but in the injection treatment the pad is made up of the patient's own tissues and held in place by the skin and fascia of the patient.

There exists a great deal of confusion in discussions of this subject. For instance a consultant to the Council on Pharmacy and Chemistry<sup>3</sup> writes that it is not conceivable that it is good judgment to inject irritating substance blindly around a sac which frequently contains part of the abdominal viscera. This objection is disposed of by limiting the treatment to reducible herniae. He further states that this treatment is dangerous. Pina Mestre reports 8000 cases and Mayer 3000 over a period of thirty years without any serious accident. Serious complications have been reported after injecting strong alcohol<sup>4</sup> but this liquid is no longer used.

## TYPES OF HERNIAE TREATED BY INJECTION

Inguinal, both direct and indirect, femoral and ventral hernia are treated or recurrences of these after operations. The principle of the treatment is the same in all these forms. The contents of the sac are

\* Submitted for publication August 10, 1931.

first reduced and the opening in the abdominal wall is located and the injection is made near the neck of the sac, the forefinger acting as a guide and then a truss is applied. After two or three injections the hernial opening is closed by fibroplastic tissue and the truss is used only as a support until the scar becomes sufficiently firm.

#### SOLUTIONS USED

There are a number of solutions used. As a rule each observer has his own favorite formula; these are mostly secret and sometimes they are sold for a considerable price. There are three basic solutions and most others are variations of these. Alcohol was introduced by Schwalbe in 1876.<sup>5</sup> Mayer's solution has the following composition:

Zinc sulphate.....	4.0
Phenol.....	24.0
Glycerine.....	15
F. E. pinus canadensis (dark).....	18
Water.....	60

Another favorite formula is that of Pina Mestre, called hernial.<sup>3</sup> The composition of this is given by Jameson<sup>6</sup> as follows:

Catechu.....	15.0
Monesia.....	14.0
Krameria.....	14.0
Rosa canina.....	15.0
Caccinium myrtillis.....	17
Alcohol (98 per cent).....	25

This formula is indefinite and the preparation in ampoules must be obtained from the manufacturers in Barcelona. Mayer's solution has advantages but is painful to use; some say that it is not but any physician can readily clear up this point by injecting 2 to 3 c.c. of Mayer's solution in his own groin. Another objection is that the zinc salt is rapidly ionized and the effect is of short duration and necessitates frequent treatments. The tannic acid molecule which is the active ingredient of the Pina Mestre solution is much larger and disintegrates more slowly and the effect is maintained over a longer period of time, about a week.

The exact formula of the Pina Mestre solution is not available but by a little

experimentation we have succeeded in making a preparation that has essentially the same effect and in some respects we think is superior to it. The composition is as follows:

Tannic acid.....	1.0
Ext. hamamelis U.S.P.....	50.0
$\frac{1}{10}$ of 1 per cent butyn sol. in water.....	50.0
Metaphen (1:500).....	1.0

This solution must be freshly prepared as solutions of tannic acid do not keep although the effects of the colored solution are the same as that of the fresh clear solution. In the technique of Pina Mestre as given by Jameson novocaine is injected first and then the irritating solution introduced, necessitating two separate injections. By combining the tannic acid and local anesthetic in one solution only one injection is necessary, thereby simplifying the technique. If care is taken to inject the solution slowly there is no pain whatever. Two or three hours after the treatment when the anesthesia wears off a sense of soreness is experienced and a tender mass appears at the site of injection. The size of the mass and the soreness are proportional to the quantity of the fluid injected and both reach their height about twelve hours after the treatment. It takes about a week for the mass and tenderness to completely disappear.

#### TECHNIQUE

To successfully treat a hernia by means of injections requires as much knowledge as to operate. Once it is decided to carry out this treatment the patient should be fitted with a truss, as a rule it is not wise to begin the treatment at once. A truss produces a certain amount of irritation at first and it is well to allow the patient to become thoroughly accustomed to wearing an apparatus before beginning treatment. Before the injection is made the patient is examined carefully in the recumbent position and the hernia reduced. With the index finger in the hernial opening for a guide 2 to 3 c.c. of the solution are injected with an ordinary hypodermic needle

near the opening in the abdominal wall. Care must be taken not to inject the cord. Once the injection is completed the truss is applied and the patient allowed to go about his business. If there is more soreness than usual a hot water bag usually gives relief or a mild sedative may be given. As a rule weekly injections are sufficient.

The number of injections necessary will vary with the solution used and specially with the skill of the operator. Mayer states that he gives 15 to 30 injections. With the Pina Mestre solution it usually requires less than this to effect closure of the hernial opening.

#### COMPARISON OF RESULTS FROM OPERATION AND INJECTION

The enthusiasts of this method certainly exaggerate the advantages and minimize the results of operation. They compare the results of an expert in the injection treatment with that of an ordinary operator. This is manifestly unfair. Our experience which includes familiarity with both methods has convinced us that while it is certainly possible to cure a hernia by injections, operation is to be preferred as a routine measure. The injection treatment has merits, however, and it would be wrong to ignore the advantages of this method. Before undertaking this form of treatment one must be sure of the indication. The small danger of operative treatment and the likelihood of recurrence are more than offset by the number of treatments and the time necessary to effect a cure by injections. Our best results with injections have been with recurrent herniae. If the sac is

detected when small the weakness in the abdominal wall may be reinforced with a minimum of inconvenience to the patient and the surgeon can be spared the humiliation which accompanies surgical failure.

An unusually satisfactory result we have obtained with the injection treatment was that of a ventral hernia following a hysterectomy for fibroids in an obese patient. When we saw this patient two unsuccessful attempts had been made to repair the abdominal wall. We made a wide excision of the sac and surrounding scar and repaired the edges carefully but shortly after it was evident that as a result of weakness of the fascia recurrence was taking place. By means of injections the abdominal wall was reinforced and recurrence did not occur.

It is unfortunate that this treatment has not received the consideration that it deserves; it is either ignored or condemned by persons who have little experience with it or offered as a complete substitute for operation in the treatment of hernia. The truth lies somewhere between these extremes.

Any surgeon who is called upon from time to time to treat recurrences of other surgeons or possibly some of his own will find it well worth his while to familiarize himself with this method of cure and then there are special instances when for some reason or other operation is contraindicated. If the limitations of this treatment are kept clearly in mind and an exact technique carried out, gratifying results may be expected from the injection treatment of reducible herniae.

#### REFERENCES

1. Cruden's Concordance. New ed. by Alfred Jones. N. Y., Revell.
2. KÖRNER, O. Die Ärztlichen Kenntnisse in Ilias und Odyssee. Munich, Bergmann, 1929.
3. Hernial (inyecciones proliferantes obturadoras del Dr. E. Pina Mestre) not acceptable for N.N.R. *J. A. M. A.*, 94: 339, 1930.
4. GOLDHAHN, R. Hernia therapy: Serious complications following alcohol injections. *Klin. Wchnschr.*, 9: 1447; 1968, 1930.
5. Wyss, F. Hernia, therapy: Treatment with alcohol injections. *Schweiz. med. Wchnschr.*, 59: 85-89, 1929.
6. JAMESON, F. S. Treatment of hernia by injection, ambulatory and non-operative relief following the method of Pina Mestre. *Clin. Med. & Surg.*, 38: 172-175, 1931.

[For remainder of References see p. 514.]

# AN AID IN THE DIFFERENTIAL DIAGNOSIS OF THE ACUTE SURGICAL ABDOMEN FROM INTERCOSTAL OR PARIETAL NEURALGIAS\*

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THE diagnosis of acute appendicitis, perforated peptic ulcer, acute pancreatic necrosis, acute intestinal obstruction, acute cholecystitis with or without stone, and the diagnosis of the many other acute abdominal lesions has become fairly well standardized; yet every once in a while we advise or perform immediate laparotomy for some acute suspected abdominal catastrophe and are chagrined after long and careful search, evisceration and much trauma, that no surgical lesion can be found to account for the severe abdominal pain, tenderness and rigidity. An error has been made in diagnosis and surgical judgment which cannot justifiably be charged against the surgeon because of lack of an accurate method of differentiating the so-called intercostal parietal neuralgias from the acute surgical abdomen which they so perfectly mimic. As a result very sick patients are frequently subjected to abdominal exploration when such procedures are distinctly contraindicated.

To Dr. J. B. Carnett,<sup>1</sup> Professor of Surgery, Graduate School of Medicine, University of Pennsylvania, credit is due for his recent revival of interest and the focusing of attention of medical men on the importance of the neuralgias of the abdominal wall, and the facility with which they simulate a great variety of intra-abdominal affections.

The so-called non-surgical abdomen or intercostal or parietal neuralgia may be due to a great variety of causes and is a symptom-complex rather than a disease per se. Included in this group are the following: acute pleurisy, basilar pneu-

monia, herpes zoster, especially before the appearance of skin eruptions, fracture of the rib or spine, injury to the chest or abdominal wall, tumors of the spinal cord, meningitis, early tetanus, injections of antitoxin, sprain of a vertebral joint, spinal curvatures, arthritis of spinal vertebrae, bone spurs of the spine, Pott's disease of the spine, cancer of the spine, pulmonary tuberculosis, angina pectoris, diabetes, lead, alcohol and arsenic poisoning, gastric crises, anemias, and blood dyscrasias.

In order to detect parietal tenderness and to exclude underlying visceral tenderness, Carnett devised a test consisting in having the patient force the diaphragm down and holding the abdominal muscles tense to protect the abdominal viscera from palpating pressure. Any tenderness elicited during this maneuver he interpreted as parietal. But he also states that parietal tenderness occurs in the three layers of the abdominal wall which include the skin and its underlying fat, the muscles and their aponeuroses and the last layer, the parietal peritoneum and transversalis fascia. This test, as Dr. Carnett admits, is inadequate and does not accurately differentiate the combined tenderness of all three parietal layers of the abdominal wall from the tenderness due to pressure on an intra-abdominal diseased, traumatized or inflamed viscus.

The writer has been observing the phenomenon hereinafter described in all the acute surgical abdomens which have been operated upon under spinal anesthesia during the last two years which have come under his personal observation during that

\* Presented in abstract before the regular monthly clinical staff conferences of the Beth Moses Hospital May 14, 1931; Greenpoint Hospital May 21, 1931.

period. A recent case of a patient having a perforated peptic ulcer operated upon under spinal anesthesia will serve to illustrate the factors involved. It was fortunate that in this particular case there was a fifteen-minute interval to effect complete surgical anesthesia. This interval between the time of injection of the anesthetic agent into the subarachnoid space and the completion of surgical anesthesia is named for the purpose of this study the diagnostic interval.

#### CASE REPORT

Mr. L., aged fifty-five years, white, city fireman, chronic alcoholic, was awakened suddenly from his sleep at 2.00 A.M. April 13, 1931, with severe, excruciating pain in the upper half of the abdomen. Ordinary house remedies (sodium bicarbonate and hot water bag) gave no relief. At 4.00 A.M. the family physician was called and sent the patient to the hospital. He was seen by the writer at 5.00 A.M. that day. Examination revealed the classical symptoms and signs of perforated peptic ulcer, viz. boardlike rigidity of the entire abdominal wall, marked skin hyperesthesia, excruciating pain and tenderness. Operation under spinal anesthesia, 150 mg. of novocaine, third lumbar space, patient in Trendelenburg position. Numbness and tingling in both legs in two minutes. Complete motor paralysis of lower limbs in five minutes. Skin anesthesia immediately above suprapubic line at five minutes (pinching with mouse-tooth forceps). Pressure with stick sponge on lower half of abdominal wall caused excruciating pain. Skin anesthesia complete up to level of umbilicus at eight minutes. Deep pressure on abdominal wall below level of umbilicus still caused severe pain. One-inch skin incision, right rectus muscle, hurriedly carried through into peritoneum below level of umbilicus, each layer being lifted up towards the ceiling as it was cut, thus avoiding pressure on the abdominal contents. The 1 in. incision was complete between the eighth and tenth minute and caused no pain, whereas sponge-stick pressure below level of umbilicus anywhere on the abdominal wall still caused excruciating pain. Skin anesthesia beginning to creep up above level of umbilicus and was complete to ensiform and nipple line in fifteen minutes,

although pressure between the tenth and fifteenth minute on abdominal wall above level of umbilicus caused excruciating pain, whereas extension of skin incision upward into this area with similar technique as used before, during the tenth and fifteenth minute interval, caused no evidence of pain.

*Pathology found:* Perforated duodenal ulcer with free fluid and gastric contents in abdominal cavity.

*Procedure:* Double purse-string suture with omental reinforcement.

Patient made an uneventful recovery.

What happened here, as well as in many other similar cases, can best be interpreted on an understanding of the relationship of the anatomy and physiology of the sympathetic nervous system to the spinal cord.

The entire nerve supply of the lateral and anterior abdominal wall is derived from the seven lower intercostal and first lumbar nerves. These nerves are mixed and contain motor and sensory fibers. It is a peculiar fact that the head, limbs and body walls contain no sympathetic sensory fibers. The visceral peritoneum and intra-abdominal viscera are supplied by the vagus and the sympathetic nerves derived from the bilateral thoracico-lumbar ganglionated sympathetic chain on either side of the vertebral column regulating in a beautifully counterbalanced physiologically antagonistic system by reciprocal innervation the vasomotor action of blood vessels, the secretion of glands, the contraction of involuntary muscles in the filling and emptying of the abdominal viscera.

Ried and DeWitt<sup>2</sup> have pointed out:

The impulses conveyed by the visceral sensory fibers normally do not enter consciousness, but when intensified by visceral disease or malfunction may give rise to painful sensations which are not accurately localized and are referred to a cutaneous area supplied by sensory fibers from the same spinal segment.

It is common knowledge that under local anesthesia of the abdominal wall the stomach or intestine or other viscera may be cut without pain, and yet when these same viscera are undergoing pathological



changes of the acute variety or abnormal function, due to a block in the outlet of a hollow viscus, excruciating pain is experienced, localized not only in the viscus which is the site of its origin, but almost always in a somatic area which is supplied by nerves connected with the same segments of the central system as those which supply the viscus in question. Pain which is localized in an area other than that which is the site of its origin is known as referred pain. The anterior roots of the thoracic and upper two lumbar segments of the spinal cord send their fibers to ganglionated cords. The efferent medullated or preganglionated or white rami communicantes fibers pass to the ganglia in the sympathetic chain or to the ganglia at the bifurcation of blood vessels or in distant ganglia situated near the structure supplied. Originally, each ganglionated cord contained as many ganglia as there are spinal nerve roots, but the number has been somewhat reduced by the amalgamation of the adjacent ganglia. Thus in the cervical region the original eight pairs are represented by three pairs, namely, the superior, middle and inferior cervical ganglia. In the thoracic region the first, second, third or fourth ganglia on each side may be condensed to form a large stellate ganglion. From these three systems of ganglia non-medullated post-ganglionated fibers proceed to their destination. Those that pass from the proximal collateral ganglia enter the spinal nerves, the latter then being known as a made-up nerve.

The afferent visceral sensory fibers pass from the viscera into the sympathetic chain and proceed without interruption via the white rami into the mixed nerve trunks and thence to their cells of origin in the posterior spinal cord root ganglion and then the central axons pass by way of the posterior roots into the posterior horns, establishing contact with the elements of the cerebrospinal central nervous system; or having passed into the sympathetic chain, proceed upward in the ganglionated cord through ganglia at higher levels, and

without interruption pass similarly via the white rami into mixed nerve trunks at these higher levels.

The contacts made by these afferent sympathetic fibers occur in three ways:<sup>3</sup> 1. With the primary efferent connector neurons in the intermediolateral columns, by means of which gastric and intestinal visceral reflexes and vasomotor reflexes are brought about. 2. With voluntary neurons in the anterior horn, by means of which visceral motor reflexes are brought about, as, for example, contraction of the abdominal muscles in cases of gastric irritation. 3. With the sensory system of the voluntary nervous systems: with the sensory cells in that segment of the spinal cord in which they have entered. Thus it is that sensory impulses arising from a viscus give rise to cutaneous pain or tenderness which is referred to the area of distribution of the posterior root belonging to that segment: this is known as referred pain.

In the light of this knowledge the interpretation of the significance of the so-called diagnostic interval can readily be understood. After low spinal anesthesia when skin anesthesia appears one can definitely say that there is underlying parietal anesthesia involving all layers of the abdominal wall, because the spinal or somatic nerves have been blocked at the level tested by pinching the skin. The sympathetic ganglionated cord is not directly affected by spinal anesthesia, but indirectly, and then only from below upward as the ascending cord paralysis blocks the afferent sympathetic pain impulses traveling to the spinal cord via the white rami communicantes. Sensory painful sympathetic visceral afferent impulses are allowed to ascend along the ganglionated chain to higher unblocked or as yet unanesthetized segments of the spinal cord; but soon the surgical or diagnostic interval is gone and the ascending spinal cord anesthesia has reached a high enough level to block all possible inroads of painful visceral impulses. The length of the surgical or

diagnostic interval will, therefore, vary indirectly as the rate of ascending diffusion of the injected anesthetic agent. The rate of such diffusion depends on certain accepted factors, viz., height of level of injection, dosage of drug used, nature of anesthetic agent, volume and character of solvent, use of expanding procedure, force of injection, position of patient.

Recently a quinoline derivative, in small doses, 5 to 10 mg., has come into favor. The surgical or diagnostic interval with its use varies from twenty to thirty minutes and it is, therefore, especially adapted as an agent in the aid in the differential diagnosis of the acute surgical abdomen from the intercostal neuralgias. The test should be applied quickly during the surgical or diagnostic interval by two maneuvers: skin pinching with mouse-tooth forceps, beginning over the suprapubic region and extending upward, and pressure with sponge stick over the anesthetized skin area as soon as the latter is elicited. A positive test, if accurately and intelligently applied, is pathognomonic of an acute surgical abdomen. There can be no doubt then that immediate operation is imperative. A positive test is most frequently found in acute surgical lesions of the upper half of the abdomen. By a positive test is meant visceral pain elicited by sponge-stick pressure on an overlying anesthetized skin area.

It is reasonable to assume that the surgical or diagnostic interval will be very much shorter in acute surgical lesions in the lower half of the abdomen, or even absent or negligible in acute pelvic lesions, although the case has often been positive in early severe lesions of the appendix. The overlying skin anesthesia may appear simultaneously with the corresponding underlying visceral anesthesia. A negative test, therefore, in the lower half of the abdomen is not to be interpreted as an absence of a surgical lesion.

Fortunately, the intercostal neuralgias mimic most often lesions in the upper half of the abdomen.

Assuming a case of severe tenderness, pain and rigidity of the entire abdominal wall due to an early lower pneumonia or pleurisy will occur. Clinical findings indicate a possible acute perforated peptic ulcer and operation is advised. Low spinal anesthesia is advised. Skin anesthesia below umbilicus is absolute and complete in two minutes. Skin anesthesia is slowly ascending. Pressure with sponge-stick over anesthetized skin, as soon as such anesthesia appears, causes no pain, especially in the upper one-half of the abdomen, whereas previous to the administration of spinal anesthesia pinching of the skin elicited extreme hyperesthesia and pressure by palpation above the umbilicus elicited excruciating pain. This would indicate a typical negative test and point to the absence of an acute intra-abdominal lesion. Such a case is better left alone, or if the patient is operated upon the abdomen should be opened through a small incision and if no immediate evidence of pathology is found, such as free fluid or peritonitis, the abdomen should be closed without further exploration.

Therefore a negative test indicates no visceral pain elicited by sponge-stick pressure on an overlying anesthetized skin area as elicited by skin pinching.

Such a test in the upper one-half of the abdomen will help to rule out an acute surgical lesion. A negative test in the lower one-half of the abdomen is not as yet accurately defined since the diagnostic interval here is often of too short a duration.

#### CONCLUSIONS

1. Intercostal or parietal neuralgias are common and often mimic the acute surgical abdomen.
2. Heretofore experienced clinical judgment was the only means of differentiating the two conditions and then not always correctly.
3. Low subarachnoid block causes a relative separation or dissociation of the spinal cord and the ganglionated sympathetic cord for a varying interval. This

surgical or diagnostic interval is particularly noticeable in surgical lesions of the upper half of the abdomen.

4. Parietal anesthesia and visceral anesthesia do not appear simultaneously: parietal anesthesia appears before visceral anesthesia and they both appear from below upwards.

5. There is therefore an interval which allows time to determine whether the pain is parietal or visceral.

6. The rate of ascension of spinal anesthesia depends upon the height of injection of the anesthetizing agent, force of injection, amount of spinal fluid withdrawn and the amount of fluid injected, the physical and chemical nature of the injected agent and the position of the patient before and after injection.

7. The use of spinal anesthesia as an aid in the differential diagnosis of the acute surgical abdomen should be so used

as to allow of slow ascension of the anesthesia along the spinal cord.

8. This study has also<sup>4</sup> conclusively demonstrated that so-called visceral or abdominal pain has three components, namely, (a) pure visceral pain felt inaccurately in the viscus affected; (b) referred pain to some portion of the parietes especially its cutaneous constituent; (c) pain caused by involvement of the parietal peritoneum.

9. Recently the use of a quinoline derivative as an anesthetic agent has allowed of a longer diagnostic or surgical interval.

#### REFERENCES

1. CARNETT, J. B. *S. Clin. North America*, 10: 1309, 1930.
2. LEWIS, D. *Loose Leaf System of Surgery*. Vol. 3, Chap. 8.
3. *Oxford Loose Leaf Medicine*. Vol. 6, Chap. 29.
4. MORLEY, J. A new theory of abdominal pain. *J. A. M. A.*, 97: 258, 1931.



#### REFERENCES OF DR. SAKLAD\*

19. ENGE, L. A., and HOFFMAN, P. E. Clinical observations on sodium amytal. *AM. J. SURG.*, 9: 17, 1930.
20. ESTEL. Pernocton, a soporific as an addition to anesthesia. *Med. Klin.*, 25: 783-784, 1928. Abst.: *Schmerz*, 2: 38, 1929.
21. ESTES, A. M., and BURGE, W. E. A study of sugar metabolism in animal cells with reference to effect of anesthetics. *Anesth. & Analg.*, 7: 79, 1928.
22. FEDERLIN, F. Pernocton in inhalation anesthesia. *München. med. Wchnschr.*, 1: 346-347, 1928, Abst.: *Narkose. U. Anaesth.*, 2: 58, 1929.
23. FITCH, R. H., WATERS, R. M., and TATUM, A. L. Barbiturates in surgery. *AM. J. SURG.*, 9: 110, 1930.
24. FOX, M. J. Progress in intravenous anesthesia. *N. England M. J.*, 203: 1079, 1930.
25. FRIEDLAENDER, B. The therapeutic indications of the sodium salt of the secondary butyl- $\alpha$ -bromallyl barbituric acid. *Anesth. & Analg.*, 10: 26-38, 1931.
26. GANTZKOW, EGON. Experiences with pernocton. *Zentralbl. f. Gynäk.*, 53: 474-475, 1929. Abst.: *Schmerz, Narkose, Anaesth.*, 2: 198, 1929.
27. GARRETT, G. H. Blood changes after anesthesia. *U. S. Veterans Bureau M. Bull.*, 4: 24, 1928.
28. GAUSS, C. J. Pernocton-scopolamin twilight sleep. *Schmerz*, 2: 130-135, 1928. Abst.: *Schmerz*, 2: 130-135, 1928. Abst.: *Surg., Gynec., Obst.*, 49: 154, 1929.
29. GESSNER and NAUHEIMER. Pharmacological studies of percain. *Schmerz, Nark. u. Anasth.*, 32: 44, 1930.
30. GINESTY, LASSALLE and MERIEL. Chemical modifications of blood in general anesthesia with somnife. *Compt.-rend. Soc. de biol.*, 91: 1399, 1924.
31. GOSSMAN, J. Avertinnarkose Frage. *Zentralbl. f. Chir.*, 55: 395, 1928.
32. GOWAN, L. R. Use of sodium amytal in nervous disorders. *Minnesota Med.* 13: 874, 1930.
33. GRUBER, C. M. Effect of barbituric acid derivatives on smooth muscle. *J. Pharmacol. & Exper. Therap.*, 27: 248-249, 1926.
34. GRUBER, C. M. Influence of barbituric acid, of some benzyl derivatives and of the hydrogen ion concentration of fluids on tonus and rhythmic movements of excised segments of intestines, uterus, and ureters. *J. Pharmacol. & Exper. Therap.*, 30: 149-162, 1926-1927.
35. GRUBER, C. M., and BASKETT, R. F. 1. The effect of phenobarbital (luminal) and sodium phenobarbital (luminal-sodium) upon blood pressure and respiration. *J. Pharmacol. & Exper. Therap.*, 25: 219, 1925.
36. GULEKE, H. Tribromethylalcohol narcosis for phrenic exeresis. *Zentralbl. f. Chir.*, 56: 2, 1929.

[For remainder of references see author's reprints.]

\* Continued from p. 465.

# A CASE OF UNUSUAL SUBLINGUAL DERMOID\*

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PASSAIC, N. J.

**E.** C. a girl, aged eleven, was referred to me by Dr. Philip Simon, on July 28, 1931, with a large tumor filling the oral cavity. There are two slightly elevated plaques in the lining. Microscopic: Dermoid cyst. The child made an uneventful recovery



FIG. 1.

oral cavity. The child had always been in good health except that since she was about two years old she had had a swelling under the tongue which became steadily larger until the child was unable to protrude the tongue, and both speech and swallowing were very much impaired. It was also noticed that the lower jaw began to protrude. At the time of the examination the child was only able to take fluids with difficulty, her breathing too was more or less obstructed. The father stated that nothing had been done about this growth because they were afraid of an operation and they "pitied the little thing."

Physical examination showed a sparsely nourished child with a moderate grade of anemia, quite intelligent, with an anxious expression. It was difficult to understand her speech. There was some puffing under the eyes and the lower jaw showed marked protrusion. The entire oral cavity was filled with a large soft rounded fluctuating mass. Her physical examination was otherwise negative.

On July 30, the tumor was excised under local anesthesia and was found to extend back to the base of the tongue and the pharynx.

Pathological Report: The tumor is cystic in nature, weight 97 gm., measuring  $6.5 \times 6 \times 5.5$  cm. The specimen is filled with fatty

following the operation and was able to protrude her tongue from her mouth for the first time in years. She began to eat with a very ravenous appetite and has gained weight steadily since the operation.



FIG. 2.

The accompanying illustrations show the child immediately before and after the operation and also the exact size of the tumor.

DISCUSSION: This type of tumor was generally regarded as a ranula until the excellent review by Colp in 1925. As shown by him more careful microscopic examination places these tumors among the dermoids.

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# DERMOID CYST OF THE TEMPORAL FOSSA\*

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**T**UMORS of the temporal fossa are rare surgical specimens and are apparently reported even less frequently than they occur. We therefore feel that a report of a case of dermoid cyst of the temporal fossa is justified and should prove of some interest. A fairly comprehensive review of the literature reveals very little concerning tumors of this region. Bloodgood,<sup>1</sup> in an experience extending over twenty-three years, has seen but 7 cases in all: 5 of these were explored and a definite diagnosis made, while in 2 cases a positive diagnosis was not determined. The 5 cases in which an exploratory operation and biopsy were performed were classified as follows: one was a gumma, one a dermoid cyst, one a myxosarcoma metastatic from a brain tumor and two were Ewing's sarcoma of bone. From a review of these cases, Bloodgood naturally concludes a malignant condition to be the most frequent tumor seen in this region.

Learmonth and Kernohan<sup>2</sup> have recently reported 3 cases of epidermoid cyst of the brain. However, the case reported herein was definitely extradural, and while it must be realized that a histologically similar tumor may arise from intracranial cell inclusions, they do not simulate tumors of the temporal fossa, and usually arise near the midline.

The patient, who is the subject of this report, is a young white female, aged twenty years. She was admitted to the North Louisiana Sanitarium on July 13, 1931, being referred by Dr. S. C. Barrow. She complained of a right-sided exophthalmos and pain in and about the right eye, with slight diplopia, these symptoms being of approximately three weeks' duration. Analysis of the history revealed that she had noticed some slight swelling just above the right zygomatic arch for about one year, which

though slightly noticeable, had been largely ignored, as it had otherwise been asymptomatic. Approximately three weeks prior to admission, however, there had been a rather sudden onset of intense pain in and about the right eye, with a sudden marked proptosis of this eye developing. Vision had been only slightly affected, a diplopia occurring apparently as a result of the two eyes being suddenly thrown out of line. Except for this diplopia, some pain (though it had subsided after the first acute attack) and exophthalmos, the patient had no particular symptoms. In retrospect, the patient recalled an injury to this region (right temporal), received when a child, the sharp edge of a saw tooth having struck her here. However, it had occasioned only immediate trouble, and had been forgotten until she was questioned closely.

Physical examination likewise revealed comparatively little definite information. The ophthalmological examination (Dr. L. W. Gorton) showed a definite, well-marked right-sided exophthalmos, non-pulsatile, and with a grossly normal bulb. The fundi were normal, as were the pupils and their reactivity. No contraction of the visual fields or other ocular phenomena were noted, excepting the diplopia and some photophobia.

A definite fullness was present in the right temporal region, evident above the zygomatic arch. This swelling was not pulsatile, and careful auscultation about the head revealed no murmurs or bruits. Careful examination of the rest of the body failed to reveal any abnormalities.

A spinal survey revealed normal-appearing fluid, under normal pressure, which was also cytologically, chemically and serologically normal.

Routine laboratory studies, including urinalysis, blood picture, blood chemistry and serology showed no deviation from the normal.

Roentgen examination (Dr. S. C. Barrow) of the head showed a well-marked erosion along the external border (posterior aspect) of the orbital ridge.

\* From the Surgical Section, North Louisiana Clinic. Submitted for publication November 3, 1931.

In view of the swelling above the zygomatic arch and the erosion of the posterior aspect of the orbital ridge, it appeared quite obvious

The most probable diagnosis rested between an aneurysm or a neoplasm. In view of the history of trauma to this region, the possibility

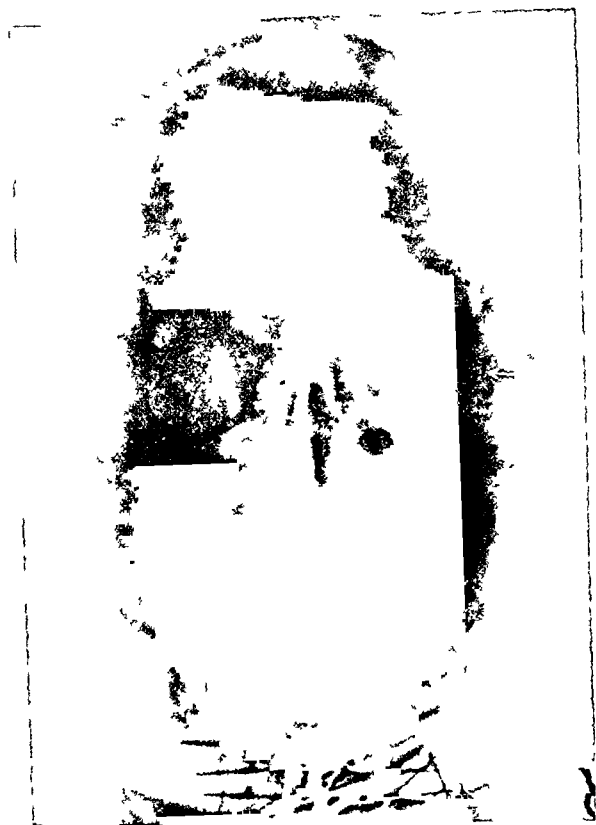


FIG. 1. Skiagraph taken prior to operation. Arrow indicates where orbital ridge on right side has been eroded, as contrasted to normal left side.

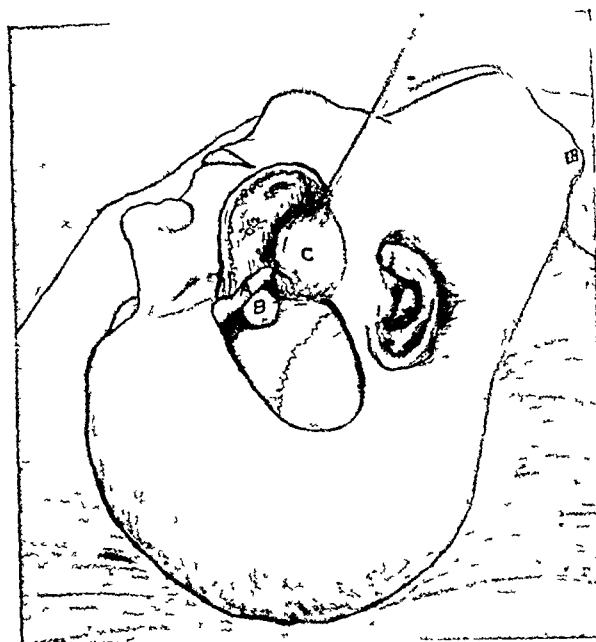


FIG. 2. Appearance of tumor as seen at operation. For sake of orientation drapes have been omitted. Our artist has failed to depict the degree of exophthalmos existing at operation. A, External orbital ridge, middle third of which was resected in order to remove sebaceous material in retrobulbar space. B, Main portion of cyst occupying temporal fossa resting against greater wing of sphenoid. c, Retracted temporal muscle, portion of which has been omitted in order to demonstrate tumor better.

that there was some type of enlargement occupying the temporal fossa. The non-pulsatile nature of the exophthalmos, the normal spinal pressure, the normal fundi, the normal visual fields all mitigated against the presence of primary intracranial or intra-orbital pathology.

The findings seemed best explicable on the basis of a slow growing lesion in the temporal fossa which had suddenly penetrated into the orbit, producing the exophthalmos and sudden, acute pain.

As to the nature of this temporal fossa pathology, there seemed three possibilities: (1) an infectious process, including a gumma; (2) a neoplasm, either benign or malignant; (3) an aneurysm. Despite the acuteness of the onset of the recent symptoms, the afebrile state, lack of local inflammatory signs, normal blood count and negative serology served to mitigate against the possibility of an infectious process.

of a traumatic aneurysm dating back to childhood, and which had caused a sudden retrobulbar hemorrhage, was considered. However, the absence of pulsation and bruit were against such a conclusion. There was nothing which could serve to rule out a diagnosis of a neoplasm, which had perhaps eroded a small vessel, and produced a retrobulbar hemorrhage.

However, it was felt that exploration was essential for a correct diagnosis. The pre-operative diagnosis was aneurysm vs. neoplasm, nature unknown. On July 15, 1931, under ether anesthesia, an exploration of the temporal fossa was made (J. E. H.). The field was prepared with benzene, iodine and alcohol, draped, and a horse-shoe incision made, starting at the external border of the superciliary ridge, extending over the temporal region and ending about  $\frac{1}{4}$  inch below the center of the zygomatic arch, the base of the flap being below. This flap of skin, fat and fascia was dissected and thrown downward and forward toward the

face, exposing the temporal muscle. About two-thirds of the temporal muscle was reflected backward, exposing the temporal fossa, in

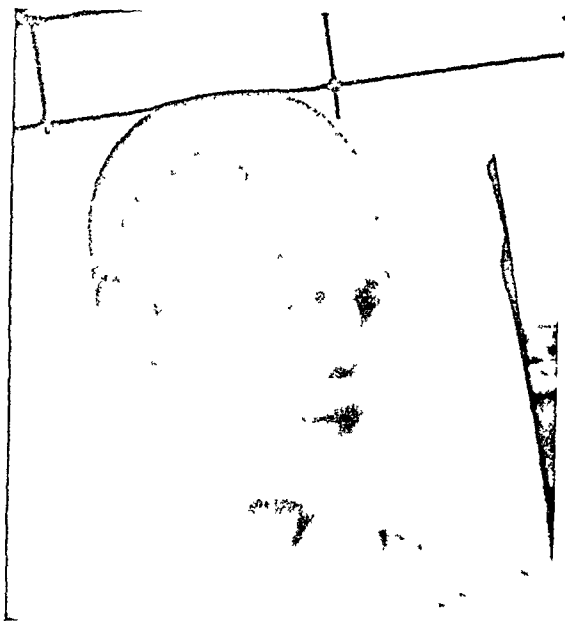


FIG. 3. Patient about two weeks after operation. Scar is a little wide because of slight suppuration at skin margins. Notice that no exophthalmos is present.

which was a small, cyst-like mass, about half the size of a peanut, with two projections extending from it: one extending through an eroded opening in the greater wing of the sphenoid, one seeming to penetrate the infra-orbital fissure. The sac was freed up to its neck, which protruded through the opening in the sphenoid, about the size of a dime. A small trephine opening was made just above the eroded opening in the sphenoid and the intervening bone rongereured away, connecting the two openings. The prolongation from the cyst in the temporal fossa was found to be entirely extradural, and was removed from the middle cerebral fossa. The eroded bone was rongereured and curetted. A small  $\frac{1}{4}$  cm. opening which had been accidentally made in the dura by the trephine was sutured with chromic oo. The sac, at this point, was opened and found to contain sebaceous-like material. The external rim of the orbit was then cut with a motor circular saw, a pyramidal-shaped piece of bone about 2.5 cm. each way being removed from the mid-portion, thus exposing the retrobulbar space. It was seen that the sac had not extended through the infraorbital fissure but had ruptured, spilling its contents into the retrobulbar space. Quite obviously, it was this sudden

rupture and filling of this space that had produced the sudden exophthalmos and pain. After the periosteum had been freed from the inner surface of the orbit, the space was cleaned out well, and the bone wired back in place with silver-bronze wire. The cyst was entirely removed and the temporal muscle sutured back in place with a continuous chromic o suture. The fascia and subcutaneous fat were closed with the same suture material, skin closure being made with a plain o subcuticular suture. Postoperative diagnosis: dermoid cyst.

Postoperatively, the patient had a splendid recovery. Except for a rather marked peri-orbital edema and discoloration, and diplopia, which lasted but a few days, the patient had an uneventful convalescence, being discharged from the hospital on July 27, 1931.

The pathologist's report was as follows: "The specimen is a cyst-like membrane which apparently has been opened and its contents removed. It is roughly  $4 \times 6$  cm. in dimensions and 1 mm. thick. The sac is lined with a glistening membrane, bluish in color, the outer surface being smooth, and grayish in color. Microscopic examination shows the cyst wall to be lined with stratified squamous epithelium, with no hair follicles or other skin appendages being evident. Small amount of striated muscle attached to outside of sac wall (temporal muscle?)."

The possibility of the sharp, cutting instrument having carried a remnant of skin into the temporal fossa, at the time of the childhood accident, and which had remained latent for a number of years, must be considered; but the absence of hair follicles makes this an unlikely possibility. The patient is alive and well now, three months after operation, with no symptoms.

#### SUMMARY AND CONCLUSIONS

1. An unusual case of dermoid cyst of the temporal fossa is presented, in which the tumor had eroded into the middle cerebral fossa through the greater wing of the sphenoid, and penetrated the retrobulbar space, producing unilateral exophthalmos.

2. The operative procedure by which this tumor was removed, is described.

3. A possible explanation is offered for the origin of this tumor by the penetration of the temporal fossa earlier in life, of a sharp instrument which may have implanted a piece of skin into this region.

[For References see p. 534.]

# DESMOID TUMOR OF THE ABDOMINAL WALL\*

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MINNEAPOLIS, MINN.

THE patient, a divorced woman of forty-one, occupied as laundress, complained of soreness and swelling in the region of

The rectus muscle was drawn well to the side, and stitched by continuous mattress sutures as indicated (Fig. 3) to all the lateral

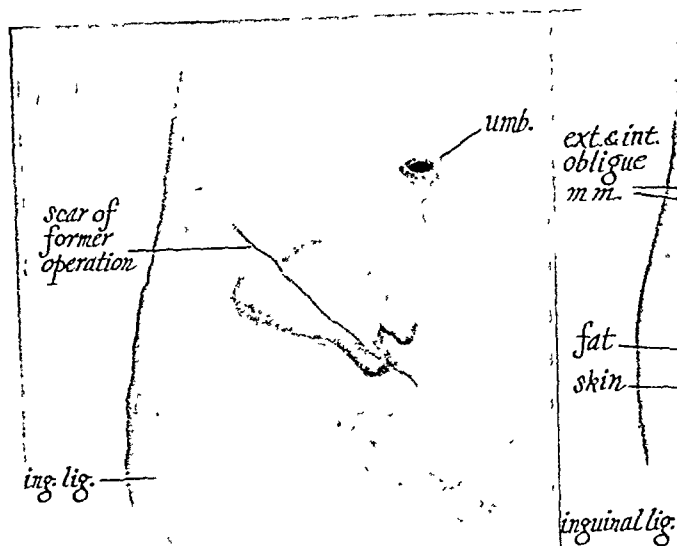


FIG. 1. Appearance of tumor.

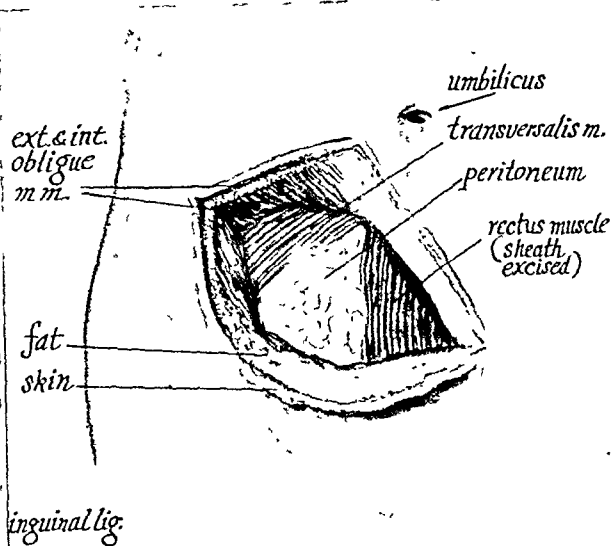


FIG. 2. After excision of desmoid.

an appendectomy scar.

There was nothing in the family or social histories at all leading. She had been married ten years and had divorced her husband one month prior to admission to our care. She had never been pregnant. She was engaged in work which was quite strenuous physically and this work had made the soreness in her right side more noticeable.

The appendectomy had been performed eleven years previously by a well-qualified surgeon, and in the fall of 1928, a mass appeared in the region of the scar. When she first noticed it, it was the size of an almond, but had now reached the size of a hen's egg (Fig. 1). There was also present some infection about the teeth and a slight enlargement of the thyroid gland.

Operation on March 27, 1929 consisted of cautery removal of the mass incising through the skin and fat with a knife to the aponeurosis of the external oblique. The tumor itself was buried in all the abdominal muscles and the excision left the appearance seen in Figure 2.

layers of the abdominal musculature. A piece of fascia lata was removed from the right thigh, 4 by 5 inches, and stitched so as to overlie the sheath defect (Fig. 4) chromic No. 2 sutures being used. The fat and skin were closed by plain No. 1 and dermol respectively.

The following day, the patient complained of sore throat. Cultures contained diphtheria bacilli and she was sent from New Asbury Hospital to the contagious ward of the General Hospital, where 20,000 units of diphtheria antitoxin were administered.

The subsequent convalescence was uneventful. The patient was up on the seventeenth day and has returned to her usual labor.

Desmoid tumors of the abdominal wall are infrequent. Still less often are they recognizable before operation. They are usually hard, not clearly defined by capsule and tend to become sarcomatous. The usual site of these tumors is over the rectus muscles, and they are more common in women than men.

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The symptoms in this case might lead one to believe that the tumor had become malignant because of the rapid growth and

type, with the reinforcement by transplant of fascia lata gave a very practical result, allowing the patient the same

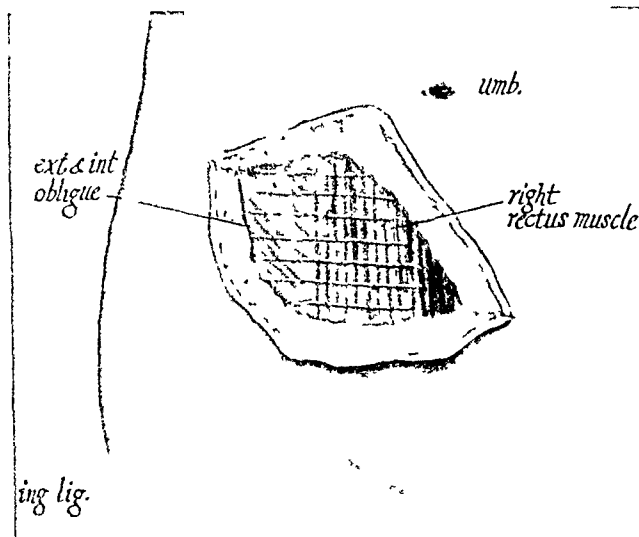


FIG. 3. Appearance of closure before fascial transplant.

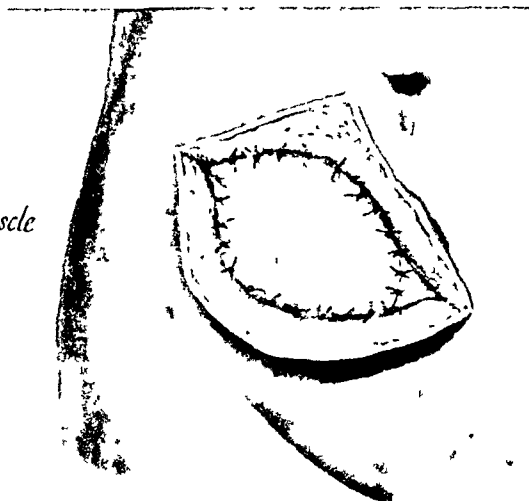


FIG. 4. Transplant of fascia lata.

pain attendant. However, the constant movement of the parts in which the tumor was buried may have produced both the growth and the tenderness. The incision was carried well around the growth, the cautery being depended on to make more remote a possible recurrence in case of malignancy.

Closing such a large gap in the abdominal wall has long been a problem. Here the use of a many-knotted suture of the mattress

strength as prior to the operation.

Diphtheria is a fairly common malady, but is most unwelcome as a postoperative complication. It may be checked certainly if recognized early. This patient must have had the organisms present in the throat before her entry to the hospital. She was removed to the contagious hospital on the day the microscopic diagnosis was made and treated promptly.



#### REFERENCES OF DR. LA ROCHELLE\*

7. MAYER, I. Treatment of hernia by subcutaneous injection; historical review and description of author's method. *M. J. & Rec.*, 125: 528; 596; 672, 1927.
8. MAYER, I. Hernia therapy by subcutaneous injection. *M. J. & Rec.*, 128: 415-418, 1928.
9. SUSONI, F., and ASTOR. Hernia therapy by proliferating injections. *Bol. Assoc. med. de Puerto-Rico*, 21: 50-53, 1928.
10. HALL, J. S. K. Hernia eradication by injections; experiments and clinical investigations with method originated by Dr. E. Pina Mestre, of Barcelona; preliminary report. *M. J. & Rec.*, 130: 61-63, 1929.
11. CAMPOS and SUBIRACHS. Hernia therapy: fibrogenic method. *Information Med.*, 6: 155, 1929.
12. MAYER, I. Hernia therapy: non-operative, with special reference to subcutaneous injection method. *Clin. Med. & Surg.*, 36: 707-713, 1929.
13. WOLLERMANN. Hernia therapy: Timmermann's injection treatment. *Aerzil. Rundschau*, 39: 283, 1929.
14. MAYER, I. Hernia therapy: Subcutaneous injections; report of 30 years' experience with 15 illustrative case reports. *M. J. & Rec.*, 131: 90-92, 1929.
15. TORNEL y CARROS, L. G. Hernia therapy: proliferating injections: cases. *Ars med. Barcelona*, 6: 178-180, 1930.

\*Continued from p. 503.

# THE RELATIONSHIP BETWEEN HYDRONEPHROSIS AND ABERRANT RENAL VESSELS

## REPORT OF AN UNUSUAL CASE OF BILATERAL HYDRONEPHROSIS ASSOCIATED WITH ABERRANT VESSELS\*

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MUCH has been written in the past two decades on the subject of hydronephrosis, and especially

The purpose of this paper is to place on record another case of bilateral hydronephrosis associated with aberrant vessels



FIG. 1. Left pyeloureterogram showing ureter filled to level of fourth transverse process beyond which it cannot be visualized. Pelvis contains no dye. That portion of ureter which is outlined appears to be dilated.

upon that phase of the condition dealing with its pathogenesis. The relationship of aberrant renal vessels to hydronephrosis, however, although frequently discussed, is still insufficiently understood and appreciated to warrant the condition being established as a definite and sufficiently frequently encountered cause for this pathological renal entity.



FIG. 2. Retrograde right pyelogram showing sac-like dilatation of pelvis, absence of calyces and dilatation of ureter.

and to emphasize the importance of early recognition of this type of anomaly as a potent cause of complete destruction of renal parenchyma.

### CASE REPORT

E. C., female, aged twenty-four, unmarried, was first seen April 6, 1931, complaining of pain in the left flank of a few weeks' duration. The pain was of a dull aching character and was accentuated by movement and by breath-

\* Submitted for publication September 8, 1931.

ing. She had to void every hour during the day and twice at night. There was no history of chills, fever or dysuria. Her appetite was

after thirty minutes no return of the dye could be seen coming through the left ureteric orifice, while that from the right was of poor



FIG. 3. Intravenous pyelogram (three hour film) showing hydronephrotic right kidney with absence of dye on left side.

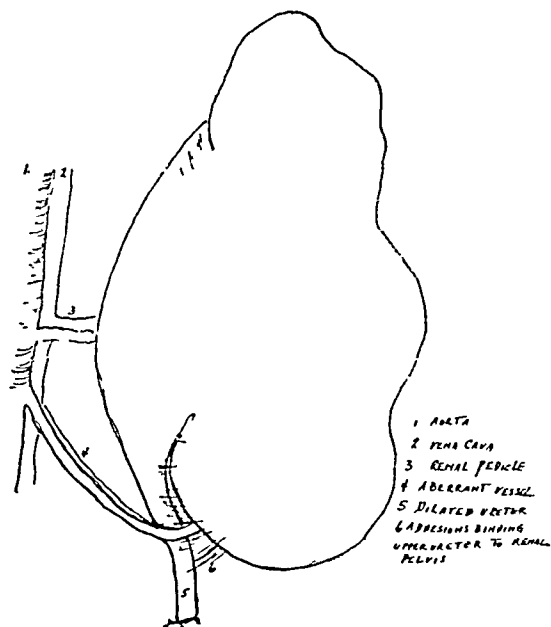


FIG. 4. Conditions found at operation.

good, and bowels regular. There was no history of cough or night sweats.

At the age of eleven, she had an attack characterized by chills and fever, which was diagnosed and treated as malaria, although the symptoms persisted for one year, following which she felt perfectly well until five months ago when she noticed black spots in front of her eyes. Four months ago she was in bed with an attack of chills and fever lasting for five days.

Family history was essentially negative.

Cystoscopy revealed a turbid, foul smelling urine in the bladder. Save for a slight injection around the ureteral orifices, the bladder looked perfectly normal. The right kidney was easily catheterized, and the urine from that kidney which contained many pus cells with clumps, showed very poor phenolsulphonephthalein concentration. The left catheter encountered an impassable obstruction at 24 cm. from the bladder, so that no urine could be obtained from that kidney. The following day, indigo carmine was given intravenously, and

concentration. Specimens from the right kidney and bladder revealed a pure growth of *B. coli communis* on culture and were negative for the bacillus of tuberculosis.

Two hour phenosulphonephthalein examination showed less than 5 per cent for the first hour and 8 per cent for the second.

**Roentgenological Examination:** A film taken with opaque catheters in both kidneys showed the tip of the right catheter lying opposite the fourth transverse process. The left catheter was seen to make a loop in the region of the lower ureter and its tip was seen lying along the lower margin of the fourth lumbar vertebra. A shadow of a calculus could not be visualized along the course of either ureter.

A left retrograde pyelogram disclosed the medium reaching to the fifth lumbar vertebra. The ureter was dilated but there was no evidence of any of the pyelographic solution within the renal pelvis. The renal silhouette appeared enormously enlarged, reaching from the twelfth rib to about 1 in. above the crest of the ilium (Fig. 1).

The right pyelogram showed the pelvis converted into a large, ovoid sac measuring 11.5 cm. by 7 cm. The ureter appeared dilated (Fig. 2).

Intravenous pycelography revealed the fact that no dye was present in either renal pelvis after fifteen minutes, although the renal of the right kidney was filled, and simulated closely the condition found on the retrograde pycelogram (Fig. 3).



FIG. 5. Kidney, immediately after its removal.

outlines were well demarcated and showed the left renal silhouette enormously enlarged, especially at its lower pole which was globular in outline and appeared to be separated from

*Blood Count:* Hemoglobin 75 per cent. Erythrocytes 4,500,000; leucocytes 12,400. Segmented forms 64 per cent. Band forms 18 per cent. Small lymphocytes 14 per cent;



FIG. 6. Kidney showing ureter stump and divided aberrant vessel. Adhesions between ureter and pelvis have been divided in preparation of specimen.

the upper part of the kidney by a groove or a line of demarcation giving the impression that it was cystic. The right kidney shadow was also markedly enlarged. A film taken one hour later still showed no dye in the left pelvis, bladder and ureters, although there was some mottling of the right renal shadow. Three hours after the injection of the dye another film was taken which again failed to show any trace of the dye in the left pelvis. The pelvis

mononuclear leucocytes 2 per cent and myelocytes 2 per cent.

*Blood Chemistry:* Urea nitrogen 31.2. Sugar 96 mg. per 100 c.c. of blood.

*Physical examination* revealed a fairly well-developed, alert and intelligent girl, twenty-four years of age, who did not appear acutely ill. The skin and conjunctivae appeared pale. A peculiar uriniferous scent was detectable from the skin and breath. The thyroid was

slightly enlarged. Blood pressure 120/80. Abdominal examination revealed two large palpable soft kidneys. There was no costovertebral

hospital on April 27 with the wound healed by primary union.

*Pathological Report:* Specimen consists of a



FIG. 7. Sagittal view of kidney showing nature of hydronephrotic changes.

tenderness. The rest of the examination was essentially negative.

From the history and findings in this case, a tentative diagnosis was made of bilateral infected congenitally hydronephrotic kidneys due either to strictures at the ureteropelvic junctures or to aberrant blood vessels. Exploratory operation upon the left completely obstructed kidney was advised.

*Operation,* April 13, 1931. Under spinal anesthesia the left kidney was exposed through an 8 in. Albarran incision. It was completely hydronephrotic and extended from the under surface of the diaphragm to the true pelvis. There was a considerable degree of perinephritis. Extending from the vena cava and aorta, two vessels were seen crossing the ureter and apparently compressing it. The upper few inches of ureter were intimately adherent to the under surface of the renal pelvis by dense adhesions. The entire renal cortex was attenuated to the thickness of writing-paper (Fig. 4). A typical nephrectomy was performed.

*Postoperative Course:* April 16, 1931. Blood urea 27.7; creatinine 3.2 mg. per 100 c.c. of blood.

April 20, 1931: Blood urea 25.9 mg. per 100 c.c. of blood.

Following a perfectly uneventful convalescence, the patient was discharged from the

kidney measuring  $17 \times 11 \times 8$  cm. On section, about 300 c.c. of thick yellowish fluid escaped from the kidney, which was completely hydronephrotic. The pelvis is markedly dilated with a number of small cysts scattered through the cortex.

Histological sections showed marked pus cell infiltration within the remains of the parenchyma with a few scattered foci of lymphocytes. Many glomeruli were completely replaced by collections of pus cells. There was no evidence of tuberculosis (Figs. 5-7).

The patient was again seen on August 1, 1931, stating that she felt well and strong. She voided eight to ten times during the day and once at night. She complained of no special symptoms. Blood pressure 138/80. Combined two hour phenolsulphonethalein test was 15 per cent. Blood chemistry (August 3): urea nitrogen 22.9 mg. per 100 c.c. of blood and creatinine 1.85 mgm. per 100 c.c. of blood.

#### COMMENT

This is a case of a girl, twenty-four years of age, who thirteen years previously was treated as a case of malaria because of chills and fever lasting for about one year. Eleven years later, because of pain in the left loin, she returned for examination which revealed a completely obstructed

and enlarged left kidney, and a definitely hydronephrotic right kidney, the combined function of both being very low as determined by the phenolsulphonaphthalein test, but in spite of which there was little retention of nitrogenous products within the blood. From the history and findings of a complete urological study a diagnosis was made of bilateral congenital infected hydronephrotic kidneys due either to obstruction at the ureteropelvic junctures or to aberrant vessels. Operation upon the left kidney revealed the obstruction to be apparently due to aberrant vessels. In view of the condition of the kidney which was completely destroyed, no alternative was left but to remove it, reasoning that since the kidney had been completely blocked, and since the patient had been carrying on a fairly normal existence, that in all probability she was living on the right kidney and that removal of the left kidney would not only not do any harm, but might enhance the function of the right kidney.

That this opinion was correct was more than amply borne out by the subsequent course of the case. Furthermore, because we found the cause of the obstruction to be due to aberrant vessels on the left side, and an hydronephrotic kidney on the right, it is not stretching the imagination too much to assume that a similar cause might be responsible for the right hydronephrosis. As to the best course to follow regarding treatment for the right kidney, it is difficult to state with absolute certainty. Should the function of the kidney improve under observation, it might be best to depend upon palliative measures such as the wearing of a properly fitted support to raise the kidney, and a low protein diet. Should the condition fail to improve, a conservative surgical procedure might be indicated to relieve the obstruction.

#### INCIDENCE

The incidence of aberrant vessels is much higher than is generally believed. Eisendrath and Strauss<sup>1</sup> examined 1200

kidneys and found aberrant arteries present in 21 per cent of them. Anomalies of the renal vein are more frequently encountered than those of the arteries, but are of little clinical importance. Young<sup>2</sup> quotes Brewer as having found in 85 bodies more than one artery on one side in a study of 151 cadavers, an incidence of 50 per cent. Lowsley, Kingery and Clarke<sup>3</sup> found 62 renal vessel anomalies in a collection of 4215 autopsies, or 1.47 per cent. Yet, it is of great significance to note that from a study of 4903 post mortems upon children, that Bugbee and Wollstein<sup>4</sup> found no case of aberrant vessels although there was a great preponderance of cases of hydronephrosis amongst them. A similar experience has been reported by Bigler<sup>5</sup> who found 20 cases of anomalies within the genitourinary tract in 153 autopsies on children, but not one case of aberrant vessels. It would appear therefore from a statistical review of the literature that aberrant renal vessels are not uncommon, and that in about 2 per cent of all children, some type of ureteral obstruction is encountered. Yet these statistics fail to show any relationship between the two conditions since no child coming to autopsy with hydronephrotic kidneys has shown the presence of aberrant vessels.

#### AGE

Symptoms due to hydronephrosis caused by aberrant renal vessels appear most frequently in early adult life, although Campbell and Lyttle<sup>6</sup> report 7 cases of patients operated on out of which 4 showed symptoms since childhood. Hutchinson<sup>7</sup> reports 22 cases, the youngest patient being fifteen and the oldest thirty-eight years of age. The age limit in Stevens<sup>8</sup> series of 13 cases was between twenty-three and sixty years.

#### PATHOGENESIS

The finding of an aberrant vessel in conjunction with an hydronephrosis does not constitute conclusive evidence that

the aberrant vessel caused the hydronephrosis. Yet, aberrant vessels do cause hydronephrosis.

Various theories have been advanced to explain the exact manner in which hydronephrotic changes are produced. Quimby<sup>9</sup> for example maintains that the mere contact of the pulsating vessel against the ureter wall suffices to interfere with its normal peristalsis, and thereby with the proper emptying of the kidney. He does not attribute the hydronephrosis to a direct mechanical occlusion of the ureter by the vessel.

Another theory advanced is that a real mechanical obstruction is produced in the ureter at the site of the aberrant vessel by pressure and by adhesions resulting from repeated infections (periureteritis) which eventually lead to a fixation of the ureter at that point.

The most plausible view is the one which explains the pathogenesis on the ground that the vessel crossing the ureter acts as an actual mechanical obstruction when associated with a movable kidney, or an infected one, the infection leading to increase in the size and weight of the organ, and thereby causing it to sag from its normal position and to produce a suspension of the pelvis or upper ureter over the vessel.

There is still another, although smaller, group of observers who maintain that aberrant vessels are in no way responsible for the presenting hydronephrosis (Spitzer,<sup>10</sup> Hahn<sup>11</sup>).

#### SYMPTOMATOLOGY

Symptoms associated with aberrant vessels are identical with those due to hydronephrosis, such as intermittent attacks of renal colic, repeated onsets of pyelitis, and a palpably enlarged kidney. Cystoscopically there is an absence of findings suggestive of calculus. Obstruction may or may not be encountered by the ureteral catheter. Pyelography shows definite evidence of hydronephrosis with or without hydro-ureter, angulation or narrowing at

the site of the lesion, and at times a break in the continuity of the ureterogram at the line of crossing of the aberrant vessel.

#### TREATMENT

The treatment of this condition is primarily surgical. Conservative surgical measures usually suffice to relieve the symptoms. Nephrectomy is reserved for kidneys which are hopelessly affected.

Various procedures have been advocated for relief of the existing obstruction. Division of the aberrant vessel, if not too large, has been successfully performed in a number of cases. Should the size of the vessel preclude this procedure because of the danger of compromising too much renal parenchyma, a better course to follow is to divide the ureter and to reunite it in such a way that any contact with the aberrant vessel would be obviated. Ureterolysis and nephropexy are useful accessories to the treatment when indicated.

The outstanding feature of the treatment is prophylaxis; that is, in the cases of obstruction at or near the ureteropelvic juncture where non-operative treatment fails to give relief in a reasonable period, exploratory operation is indicated for the purpose of instituting appropriate measures for the correction of the deformity causing the obstruction before any marked hydronephrotic changes have occurred.

#### SUMMARY AND CONCLUSIONS

1. Aberrant vessels, while not uncommon as an anomaly of the renal circulation are less commonly responsible for hydronephrotic changes of the kidney.

2. Various theories are outlined attempting to explain the manner in which such vessels produce their deleterious effect upon the kidney, their outstanding feature being some interference with the emptying of the kidney either directly or indirectly as a result of the proximity of the aberrant vessel.

3. The symptomatology associated with this anomaly is that due to the concomitant hydronephrosis.

4. The outstanding feature in the treatment of this condition is the early recognition of this anomaly which is made possible only by subjecting all cases of obstruction at or near the ureteropelvic juncture that have not responded to conservative non-operative measures to exploratory operation.

5. Division of small vessels or division of the ureter and its subsequent repair in such a way that it is free of the offending

vessel are measures frequently employed in conjunction with nephropexy and ureterolysis. Nephrectomy is employed when the kidney is damaged beyond the possibility of repair.

6. A case is here reported of bilateral hydronephrosis associated with aberrant vessels which necessitated nephrectomy of the worst kidney in order to spare its less affected mate.

## REFERENCES

1. EISENDRATH and STRAUSS. The surgical importance of accessory renal arteries. *J. A. M. A.*, 55: 1375, 1910.
2. YOUNG, H. H. Practice of Urology. Phila., Saunders, 1926, 2: 30.
3. LOWSLEY, KINGERY and CLARKE. The surgical significance of certain abnormalities of the urinary tract. *J. Urol.*, 11: 211, 1924.
4. BUGBEE and WOLLSTEIN. Surgical pathology of the urinary tract in infants. *J. A. M. A.*, 83: 1887, 1914.
5. BIGLER, J. A. Anomalies of the urinary tract in children: frequency and types in a consecutive necropsy study. *Am. J. Dis. Child.*, 38: 960, 1929.
6. CAMPBELL and LYTTLE. Ureteral obstruction in infancy. *J. A. M. A.*, 92: 544, 1929.
7. HUTCHINSON, J. Obstruction of ureter by aberrant renal vessels. *Proc. Roy. Soc. Med.*, 6: part 3, 201, 1913.
8. STEVENS, A. R. Hydronephrosis due to obstruction at the ureteropelvic junction. *J. Urol.*, 23: 496, 1930.
9. QUIMBY, W. C. Factors influencing the operative procedure in hydronephrosis. *J. A. M. A.*, 93: 1709, 1929.
10. SPITZER, W. H. The mechanism of the formation of hydronephrosis and hydroureter. *Colorado Med.*, 25: 8, 1928.
11. HAHN, E. V. Congenital hydronephrosis. *Arch. Surg.*, 9: 256, 1924.



## REFERENCES OF DR SHUTE.\*

- GUEILLETTE, R. *Bull. Soc. d'obst. et de gynec.*, 18: 274, 1929.
- HAIM, E. *Zentralbl. f. Gynaek.*, 49: 1401, 1925.
- HALLER, M. *Bull. et. mem. Soc. de chir. de Paris*, 21: 253, 1929.
- HAMANT, A. *Bull. de la Soc. d'obst. et. de gynec. de Paris*, 13: 69, 1924.
- HAMBERT, S. Abst. in *Jabresb. f. Gynek. u. Geburts.*, 36: 395, 1922.
- HAMMERSCHLAG. *Ztschr. f. Geburts. u. Gynaek.*, 97: 115, 1930.
- HANSEN, A. *Zentralbl. f. Gynaek.*, 46: 707, 1922.
- HAULTAIN, W. G. N. *J. Obst. & Gyn. Brit. Emp.*, 8: 25, 1925.
- HEIL, K. *Zentralbl. f. Gynaek.*, 45: 498, 1921.
- HIRSCH. *Zentralbl. f. Gynaek.*, 48: 549, 1924.
- HOCHLOFF, A. W. *Zentralbl. f. Gynaek.*, 53: No. 18, 1125, 1929.
- HOFFMAN, H. *Zentralbl. f. Gynaek.*, 45: 1188, 1921.
- HOLTMANN, N. Abst. in *Zentralbl. f. Gynaek.*, 53: No. 39: 2497, 1929.
- HORNUNG. *Zentralbl. f. Gynaek.*, 49: No. 37, 2076, 1925.
- HORSCH, K. *Zentralbl. f. Gynaek.*, 50: 2012, 1926.
- HUBRICH, R. *Zentralbl. f. Chir.*, 56: 665, 1929.
- HUSSY. *Zentralbl. f. Gynaek.*, 46: No. 48, 1927.
- JEFFERSON, J. C. *Brit. M. J.*, 1: 155, Jan. 9, 1926.
- KOHLER, M. *Zentralbl. f. Gynaek.*, 52: No. 44, 2813, 1928.
- KOSTER, H. *AM. J. SURG.*, 7: 67, 1929.
- KUSTNER, H. *Zentralbl. f. Gynaek.*, 48: 1294, 1924.
- KUSTNER, O. *Zentralbl. f. Gynaek.*, 14: 785, 1890.
- LAEMMLE, K. *Zentralbl. f. Gynaek.*, 47: 436, 1923.
- LAURANT, P. *Bull. et. mem. Soc. de chir. de Paris*, 21: 388, 1929.
- LEBALLE. *Bull. Soc. d'obst. et de gynec.*, 18: 273, 1929.
- LENORMANT, C. *Bull. et. mem. Soc. nat. de chir.*, 53: 624, 1927.
- LIPPERT, W. *Arch. f. Gynaek.*, 74: 447, 1904-05.
- LITTAUER. *Zentralbl. f. Gynaek.*, 51: 1406, 1902.
- LOEFFLER, A. Abst. in *Zentralbl. f. Gynaek.*, 51: No. 15, 942, 1927.
- LORY, S. *Bull. et. mem. Soc. anat. de Paris*, p. 305, May 1920.
- MANDELSTAMM, A. *Zentralbl. f. Gynaek.*, 52: No. 16, 1009, 1928.
- MARTIN, A. *Compt. rend. de la Soc. d'obst. et de gynec. et de paed. de Paris*, 8: 147, 1906.

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## TWO CASES OF LIPOMA\*

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**B**ECAUSE of the unusual size and location of the lipomata in the 2 cases described below their record is considered of value.

**CASE I.** A. N. male, aged thirty-two, white, was admitted to the Prospect Heights Hospital May 2, 1930 with the history of a swelling of the right thigh of twenty years' duration. Three months ago the swelling began increasing in size and causing some pain. Recent trauma could not be established in the history. During the years of the World War the thigh had been subjected to constant irritation in the saddle.

Physical examination was entirely negative, except for the local findings of the right thigh. This was 7 cm. larger in circumference than the left at a point midway between the greater trochanter and the upper border of the patella. This enlargement was due to a tumor occupying the entire antero-medial aspect of the thigh. With the muscles of the thigh relaxed the tumor was soft, not movable on the underlying tissue, the size and shape of a small watermelon, giving an indefinite sense of fluctuation. This pseudo-fluctuation disappeared, however, when the muscles of the thigh were tensed. No lobules could be made out. The palpation was quite painless. T.P.R. as well as all laboratory findings were within normal limits.

*Preoperative Diagnosis:* Deep-seated intermuscular lipoma of the right thigh.

*Operation:* Under gas-oxygen anesthesia an incision 20 cm. long was made over the most prominent part of the swelling in the long axis of the thigh. The fascia was incised to the same extent exposing the vastus externus. The fibers of this muscle were separated in its upper and lower portions and through these windows the fatty growth was enucleated. The lipoma extended from Scarpa's triangle to the point of insertion of the flexors of the thigh on the medial aspect of the knee. It lay immediately upon the femur and was intimately connected with the periosteum by dense fibrotic

bands. The capsule of the lipoma was well developed and very vascular. At the lower pole of the tumor the vessels formed a pronounced pedicle which was ligated. The dead space was obliterated by plicating the vastus muscle which measured about twice its normal length. A Penrose drain was placed into the lower angle of the wound, reaching into the region of the vascular pedicle. The fascia and skin were closed in layers and the patient was urged to use the limb in bed.

The pathologist reported the tumor as a simple lipoma with increased fibrous interstitial tissue and markedly rich vascularity. The tumor weighed 6 lb., and measured  $21 \times 16 \times 16$  cm. The accompanying illustrations give a good idea of the clinical and pathological characteristics of the tumor.

The convalescence was entirely uneventful. The drain was removed within forty-eight hours and three weeks following the operation the patient was entirely free of pain and well able to use the leg.

Though adipose tumors of this size and even larger are quite commonly met with in the subcutaneous tissues they are extremely rare within the deeper structures. As far as their relationship to the surrounding muscles is concerned attempts have been made to classify them into intramuscular and intermuscular varieties depending upon whether the tumor is situated between individual muscles or muscle groups or whether it is confined within the belly of any one muscle. Since the characteristic qualities of the tumor remain identical in both cases it seems unnecessary to maintain any such artificial classification and the term deep-seated would be sufficiently descriptive of this type of growth.

The diagnosis of deep-seated lipomata is usually simple, if their long history, the absence of pain and fluctuation and their

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characteristically elastic consistency are noted. Some difficulty in their differentiation may be encountered in the thigh and the back where the overlying groups of muscles are large and palpation is difficult. In these locations adipose tumors may be mistaken for cold abscesses. The function of the overlying muscles will usually clear this point up, inasmuch as their contraction is normal in extent and painless over a fatty tumor and guarded, incomplete and painful over an inflammatory exudate. The occasion should never arise for exploratory puncture of such swellings for diagnostic purposes.

Histologically these deep-seated lipomata differ but slightly from the subcutaneous variety. The capsule is usually very well developed, the amount of fibrous tissue and the vascular supply are generally definitely increased. Their treatment is obviously surgical removal.

**CASE II.** Mrs. C. H. white, thirty-four years old, was admitted to the Coney Island Hospital with the complaint of subsiding pain in the right lower quadrant of three days' duration accompanied by nausea, vomiting and constipation.

For the past ten years the patient had complained of a dull ache in the right lower quadrant, increasing on violent exercise and at night when lying on her right side. Occasionally this pain had been referred to the epigastrium and was then accompanied by nausea. Patient has always been somewhat constipated and has passed several blood-streaked stools within the past six months. Her appetite has always been good and her weight has remained constant. Both her marital and menstrual histories were negative.

Three days prior to admission to the hospital the patient experienced a severe pain in the right lower quadrant, and vomited once. Her temperature remained normal and her bowels moved twice that day. The stool was liquid but free of blood. Toward the evening of the same day the vomiting recurred, the pain increased and became cramp-like in character. A physician diagnosed an attack of acute appendicitis and ordered opiates and an ice bag. Next day she felt considerably improved. The stool was normal but the pain in the lower

abdomen persisted all day. On the morning of the third day operation for subsiding appendicitis was advised by the attending physician,



FIG. 1. View of lipoma before operation.

whereupon the patient was admitted to the Coney Island Hospital.

She was found to be suffering considerable pain. The right lower extremity was held flexed. The head and chest were negative. The abdomen was soft except for the right lower quadrant where there was pronounced muscle spasm on palpation. The suprapubic area was soft and painless, whereas there was marked tenderness over McBurney's point. There was an indefinite mass palpable at this point which could not be outlined satisfactorily because of muscle spasm. Pelvic examination was negative. There was no vaginal discharge. Hemoglobin 85 per cent. Red blood corpuscles, 800,000; white blood corpuscles, 11,000. Differential count normal. Urine negative. Temperature, 99.4°F., pulse, 80, respiration 14. A preoperative diagnosis of subsiding acute appendicitis was made.

At operation the gall bladder was found to be soft, compressible and did not contain any calculi. The stomach, spleen and pelvic organs were normal. The cecum was glued to the parietal peritoneum and contained a mass about the size of a tangerine within its lumen. This mass did not pit on pressure, was elastic and was firmly attached to the posterior aspect of the cecum whereas the anterior wall of the cecum could be freely moved over the surface of the tumor. The ileocecal region was slightly invaginated into the ascending colon and was edematous. The appendix was normal in size,

color and position. There were no periappendiceal adhesions. Upon recognition of the tumor in the intestine the ileum was clamped

an isoperistaltic anastomosis done. The abdomen was then closed without drainage.

The pathologist reported the tumor as a

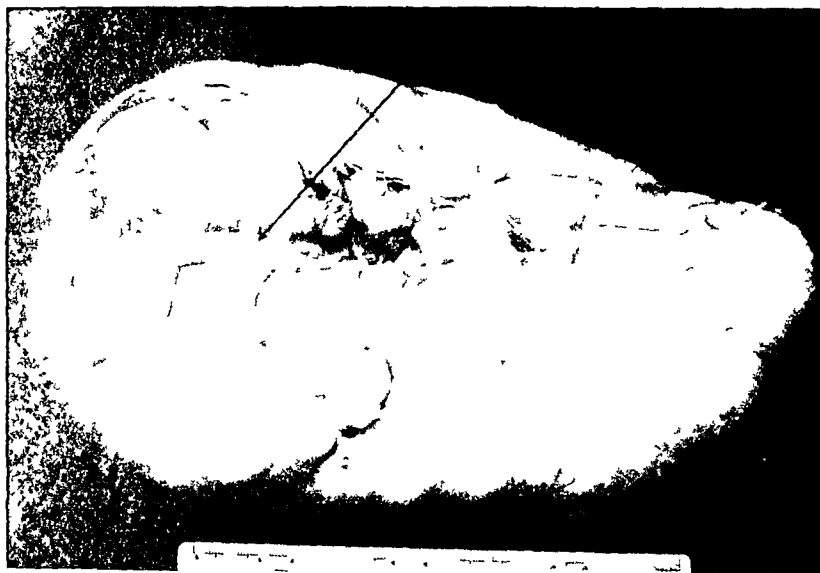


FIG. 2. Tumor removed from Case 1. Note pressure furrow (arrow) of femur.

off 8 cm. from the ileocecal junction. The cecum was mobilized by incising the peritoneum in the lateral lumbar gutter and clamped well

simple lipoma, submucous, having an area of necrosis about the size of a silver dollar on its free surface inside the lumen of the cecum.

The convalescence was entirely uneventful and at a reexamination six months later the patient was entirely free of abdominal symptoms.



FIG. 3. Specimen of submucous lipoma of cecum. a, Area of necrosis. b, Mucosa of cecum. c, Mucosa of ileum.

above the tumor mass. Both bowel ends were closed with three layers of catgut sutures and

A total of 181 lipomata of the gastrointestinal tract have been described in the literature of which 16 only were confined to the cecum. The present case, as well as the two published by Ratcliff,<sup>1</sup> should be added to the previous ones bringing the grand total up to 184. The symptomatology of a benign tumor of the cecum in a quiescent stage is most indefinite. The obvious, outstanding symptom would be obstruction in its chronic, subacute or acute form. This may be produced by blocking of the lumen of the bowel by the tumor mass itself, if large enough, or by invagination of the bowel by constant traction in the line of peristalsis. In the latter form it would be reasonable to expect peritoneal reaction of a mild nature

<sup>1</sup>Ratcliff, R. A. Submucous lipoma of the colon. *Guy's Hosp. Rep.*, 80 453, 1930.

in response to the continuous local circulatory disturbances. Thus a variety of gastrointestinal symptoms may appear, such as nausea, vomiting, constipation or diarrhea, none of which may be regarded as pathognomonic of benign tumors of the bowel. The diagnosis therefore cannot be anticipated on the history alone as it is possible in other gastrointestinal diseases. Palpation of a tumor and x-ray evidence of a filling defect in the cecum might help materially to make a definite diagnosis, but both of these signs can seldom be obtained. The patients seek relief usually when an acute calamity has occurred. We are then confronted with the picture of an acute obstruction in the presence of which few men are willing to order a gastrointestinal x-ray examination, or the peritonitis syndrome is in the foreground which effectually precludes detailed and successful palpation and x-ray study.

In the case described here an indefinite mass was made out at examination but it was attributed to the probable appendiceal exudate. Roentgenological examination did not seem to be indicated in the presence of a definite diagnosis of a subsiding appendicitis.

These cases have been reported because of their comparative rarity and for the purpose of recording them. From the second case, however, we have an important lesson to learn. That is, that a seemingly simple appendectomy, undertaken only too frequently by men of meager surgical experience, may turn out to be a formidable major procedure. It devolves therefore upon every surgeon wishing to do justice to his patient to be prepared to make an intra-abdominal diagnosis of any unusual pathological condition and to be competent to carry out the indicated major procedure.



## REFERENCES OF DR. SHUTE\*

- MAUCLAIRE. *Bull. et mem. Soc. nat. de chir.*, 53: 583, 1927.
- McILROY, A. L. *J. Obst. and Gyn. Brit. Emp.*, 18: 368, 1910.
- MENGE, K., and VON OETTINGEN, K. In *Veit-Stoeckel's Handbuch der Gyn.*, Ed. 3, 1930, 1: 549.
- MICHEL, B. *Zentralbl. f. Gynaek.*, 46: 905, 1902.
- MICHEL, B., and GUIBAL, J. *Bull. Soc. d'obst. et de gynec.*, 17: 160, 1928.
- MICHON, M. L. *Lyon med.*, 136: 7, 1925.
- MICHON, M. L. *Gynec. et d'obst.*, 21: 103, 1930.
- MICHON, M. L. *Lyon chir.*, 27: 359, 1930.
- MICHON, M. L. and COMTE. *Lyon med.*, 137: 40, 1926.
- MICHEL, G., and VERMELIN, H. *Bull. Soc. d'obst. et de gynec.*, 17: 157, 1928.
- MICHAEL, P. R. Abst. in *J. de Chir.*, p. 369, March 25, 1925.
- MICHALIKOWA, E. Abst. in *Zentralbl. f. Gynaek.*, 53: 2883, 1929.
- MILES, L. M. *Minn. Med.*, 10: 453, 1927.
- MOREL. *Bull. et mem. Soc. anat. de Paris*, Dec. 1903.
- Abst. in *J. Obst. & Gyn. Brit. Emp.*, 5: 483, 1904.
- MUIR, J. B. G. *Brit. M. J.*, 2: 730, 1930.
- MURRAY, H. L. Abst. in *Zentralbl. f. Gynaek.*, 48: 392, 1924.
- MUNROE, H. S. *J. M. A. Georgia*, 6: 169, 1917.
- MURARD, J. *Bull. et mem. soc. nat. de chir.*, 55: 1319, 1929.
- NASH, W. G. *Lancet*, 1: 78, 1922.
- NEUGEBAUER, F. *Zentralbl. f. Gynaek.*, 46: 1961, 1922.
- NICHOLSON, E. Abst. in *Zentralbl. f. Gynaek.*, 52: No. 32, 2071, 1928.
- NORRIS, C. C. *Am. J. Obst.*, 63: 850, 1911.
- OGOREK, M. *Arch. f. Gynaek.*, 102: 300, 1914.
- OGOREK, M. *Arch. f. Gynaek.*, 103: 284, 1914.
- OHMSTEDE. Abst. in *Zentralbl. f. Gynaek.*, 53: No. 39, 2500, 1929.
- PAUCOT and MERURISSE. *Bull. Soc. d'obst. de Paris*, 17: 721, 1928.
- PAYR, E. *Deutsch. Ztschr. f. Chir.*, 85: 392, 1906.
- PIREAU. *Arch. med. Belges*, 79: 161, 1926.
- POZZI, S. *Rev. de Gyn. et de Chir. Abdom.*, 4: 195, 1900.
- ROBINSON, A. L. *Clin. Jour.*, 57: 476, 1928.
- ROCHER and JEANNENEY. *Bull. et mem. Soc. nat. de chir.*, 52: 294, 1926.
- ROGERS, L. *Brit. M. J.* 1: 778, 1925.
- ROLL. Abst. in Smith and Butler: *Am. J. Obst. & Gynec.*, 2: 507, 1921.
- ROST, W. L. *Arch. Paed.*, 40: 787, 1923.
- RUDER. *Zentralbl. f. Gynaek.*, 45: 45, 1920.
- SCHAUTA, F. *Lehrbuch d. Gesam. Gynäk.*, Bd. T., pp. 405-410, 1897.
- SCHREINER, R. *Zentralbl. f. Gynaek.*, 52: No. 18: 1139, 1928.
- SCHROER, H. Abst. in *Zentralbl. f. Gynaek.*, 51: 3139, 1927.
- SCHWEITZER, B. *Zentralbl. f. Gynaek.*, 44: No. 19, 487, 1920.
- SCHWARTZ, J. *Zentralbl. f. Gynaek.*, 46: 1959, 1922.
- SCHEID, F. *Zentralbl. f. Gynaek.*, 46: 1485, 1922.

[For remainder of References see p. 528.]

\* Continued from p. 521.

# SPONTANEOUS GANGRENE OF SCROTUM & PENIS\*

WILLIAM LINDER, M.D., F.A.C.S., AND MATTHEW S. LEVITAS, M.D.

BROOKLYN, N. Y.

**A**N acute fulminating gangrene of the scrotum and penis is characterized by an abrupt spontaneous onset, a rapidly ensuing inflammation with marked edema and subsequent necrosis of the superficial tissues of the genitals (Campbell).

The object of reporting this case is to show the rapid invasion and wide destruction of tissues and the marked general sepsis which frequently causes a fatal termination. Early recognition of this entity and understanding of the anatomy of the fascial planes where the infection travels, multiple incisions and drainage which were instituted in this case, were all factors to which we attribute the complete recovery of this patient.

The following case history is that of patient D. K., a male, married, thirty-six years of age, admitted to the Israel-Zion Hospital on February 5, 1930. His previous history was negative except for his having been "gassed" during the world war. The anamnesis is as presented in the following history.

Feb. 1. Sudden onset, with chills, fever, headache, general body pains, perspiration and weakness. There were also dragging pains in the scrotum within twenty-four hours. Temperature 102.5°F. There was a scab on the left side of the scrotum, removed by the patient and leaving a small raw surface.

Feb. 2. There were severe pains and tenderness in the left side of the scrotum with a small area of redness which was rapidly spreading and was tense and shiny. The scrotum was increased in size.

Feb. 3. The process spread to the right side involving the entire scrotum and the base of the penis which became considerably edematous. There was no sharp line of demarcation. The color was dusky.

Feb. 4. There was an advancing wake of lymphangitis spreading to the inguinal and perineal regions. The scrotum was swelling, becoming more tense, shiny and edematous.

The epidermis was sloughing in chunks and there was a serous exudation from the underlying edematous tissue, "a weeping." The color was the typical dark gray of gangrene with its putrefactive odor. No crepitation however was palpable. There was moderate prostration and the temperature was 101°F. and the pulse rate 112.

Feb. 5. The changes were progressively worse. The scrotum was the size of a grapefruit. The penis was increased to more than three times its normal size. The lymphangitis invaded the lower abdomen and ischio-rectal regions which were becoming more tender.

Feb. 6. The patient was operated on by Dr. Linder under nitrous oxide-ether anesthesia. Multiple long, deep, and sweeping incisions were made on either side of the scrotum, ischio-rectal and both inguinal regions, exposing the spermatic cords. In making these incisions, it was noted that the skin was gangrenous, the subcutaneous tissue edematous and that a thin yellowish fluid oozed out. The fascia was observed to be sloughing in its entirety.

The postoperative course was stormy. The patient showed signs of prostration. The blood count was red blood corpuscles 2,170,000, Hb 48 per cent (Sahli), white blood corpuscles 19,100 and polymorphonuclears 71 per cent. A small blood transfusion sent the patient's condition up, temporarily, until he received another blood transfusion subsequently. The temperature dropped from 104.8°F. until it fluctuated between 99 and 102°F. The wounds suppurred, extended gradually by fascial continuity, until one wondered if the process invaded the abdomen or when the spreading infection would cease? When the penis was denuded except for the glans and corpora cavernosa and the scrotum had been entirely destroyed there was extension into the inguinal regions which gaped and allowed the testicles to hang "dangling" by their spermatic cords except for their covering of tunica vaginalis. Then the destruction stopped. This occurred only after two sudden hemorrhages from thrombosed vessels between the base of the

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penis and the testicles, which were clamped to control excessive hemorrhage.

The process of regeneration then took place.

fascia of the perineum (Colles's fascia) and then into the ischiorectal region.

*Bacteriology.* The organism isolated is



FIG. 1.



FIG. 2.

FIGS. 1 and 2. One year after recovery. Showing new and smaller epithelial scrotal sac. Narrowed caliber of penis. Postoperative scars.

Both testicles were intentionally coapted. They matted together and soon were covered over by new epithelial tissue bridging over to form a new scrotal sac which was smaller than the original and of a purplish color, making skin graft unnecessary.

*Pathological Anatomy.* The fascia which was destroyed invaded the following anatomical structures. From the scrotum it extends to the dartos which is the tunic of the scrotum and is a thin layer of vascular tissue continuous with the superficial fascia of the groin and perineum. This fascia then dips down into the median line or raphe, which divides the scrotum into two lateral portions and is continued forward to the under surface of the penis and backward along the middle line of the perineum to the anus. It then involves the penile fascia (the fascia of the dorsum of the penis) and then continues into the abdomen as the deep layer of the superficial fascia (Scarpa's fascia). It then involves the fascia of the urethral surface of the penis, the dartos and the scrotum and extends posteriorly to invade the deep layer of the superficial

a strain of the *Streptococcus hemolyticus*. No anaerobic organisms were isolated. We believe this gangrenous process to be due to a special strain of the *Streptococcus hemolyticus* with unusual virulence, spreading through the lymph spaces and having a predilection for the invasion of superficial blood vessels and fascia.

The skin passes through an early red stage followed by a brownish, glistening discoloration with no sharp line of demarcation, which differentiates this from erysipelas, to that of a dark gray or green when the gangrene has been thoroughly established. Then comes lymphangitis, fascial destruction, suppuration and finally epithelization.

*Treatment.* Incisions are made as soon as the diagnosis is established. We inserted Dakin tubes into the wounds and irrigated with Dakin's solution and later applied potassium permanganate soaks. We also gave the perfringens antitoxin. Other treatments were supportive.

*Course.* The sudden "explosive" onset with grippal symptoms, a small red area

on the scrotum, hastily progressing to the considerable enlargement of the scrotum and penis and an apparently comfortable condition of the patient, until soon the patient shows symptoms of the severe toxemic absorption of the necrotic products, along with exhaustion, low red cell count and hemoglobin, is striking if not dramatic.

The complete destruction of the scrotal sac, with two homeless testicles, a denuded

penis with only its glans and an adjoining collar of skin, two spermatic cords hanging freely from the external inguinal rings, are the price of bacterial invasion. A new scrotum, smaller in size but sufficient to hold the testicles, new skin to cover the deficiency of the penis and narrow its caliber, are the ultimate results.

At present, one year after recovery, the patient has been in good health and his sexual powers have been entirely preserved.

## REFERENCES

- CAMPBELL, M. F. Scrotal and penile gangrene. *Surg. Gynec. and Obst.*, 34: 780, 1922.  
 WHITING, A. D. Gangrene of the scrotum. *Ann. Surg.*, 41: 841, 1905.  
 MAC CALLUM, W. G. A Text-book of Pathology, Phila., Saunders, 1925.  
 CABOT, H. Modern Urology, Phila., Lea, 1924.  
 KEYES, E. L. Text-book of Urology, N. Y., Appleton, 1928.  
 NELSON'S Loose-leaf Surgery.  
 GRAY, H. Text Book of Anatomy. Phila., Lea, 1910.  
 CUNNINGHAM, D. J. Text Book of Anatomy. N. Y., Wood, 1922.



## REFERENCES OF DR. SHUTE\*

- SCHWEITZER, B. *Zentralbl. f. Gynaek.*, 42: 25, 1918.  
 SCHWARTZWALLER, G. *Zentralbl. f. Gynaek.*, 48: 2287, 1924.  
 SECKINGER, D. L., and SNYDER, F. F. *Bull. Johns Hopkins Hosp.*, 39: 371, 1926.  
 SELLHEIM, H. *Ztschr., f. Geburts. u. Gynaek.*, 87: 13, 1924.  
 SMITH, R. R., and BUTLER, W. J. *Am. J. Obst. & Gynec.*, 2: 507, 1921.  
 SMITH, W. S., and DENTON, J. *Am. J. Obst. & Gynec.*, 16: 205, 1928.  
 SPENCER, H. W. *N. York State J. M.*, 30: No. 7, 388, 1930.  
 SPULER, A. In: Veit. Stoeckel's Handbuch der Gyn. Ed. 3, 1930. 1: 391.  
 STARK, J. N. *J. Obst. & Gyn. Brit. Emp.*, 19: 258, 1911.  
 STEIN, I. F. *S. Clin. N. America*, 7: 763, 1927.  
 SZENES, A. *Zentralbl. f. Gynaek.*, 52: No. 42, 2720, 1928.  
 TAUBER, R. *Zentralbl. f. Gynaek.*, 52: No. 44, 2813, 1928.  
 TERRUHN, F. *Ztschr. f. Geburts. u. Gynaek.*, 92: 432, 1927.  
 THOREK, M. *Med. J. & Rec.*, 125: 470, 1927.  
 TORLAND, T. *Am. J. Obst. & Gynec.*, 15: 702, 1928.  
 TOURNEAUX, J. P. *Bull. Soc. d'obst. de Paris*, 12: 581, 1925.  
 VANVERTS, M. J. *Bull. Soc. d'obst. et gynec.*, 16: 528, 1927.  
 VENETIANER, P. *Abst. in Zentralbl. f. Gynaek.*, 49: No. 37: 2076, 1925.  
 VIGHOLT. *Acta Obst. et Gynec. Scand.*, 7: 310, 1928.  
 WACHTEL, M. *Zentralbl. f. Gynaek.*, 52: No. 23, 1453, 1928.  
 WALLAWELSKI, H. *Zentralbl. f. Gynaek.*, 54: 861, Apr. 5, 1930.  
 WELLS, J. J. *A. M. A.*, 83: 30, 1924.  
 WOOLLCOMBE, W. L. *Lancet*, 2: 1584, Dec. 7, 1901.  
 WOODS, L. S. *M. J. Australia*, 2: 439, 1928.

## FURTHER REFERENCES†

- AIGROT, G. *Vie. Med.*, vol. 11: 249, 1930.  
 BERTONE, G. *Ann. di. Ostet.*, 49: 286, 1927.  
 CAVIGLIA, A. *Semana Med.*, 1: 110, 1927.  
 DELLI COLLI, G. *Clin. ostet.*, 30: 812, 1928.  
 DRIESSEN, L. F. *Nederl. Tijdschr. v. Geneesk.*, 2: 4737, 1928.  
 GIANGIOBBE, A. P. *Semana Med.*, 1: 669, 1928.  
 GINODMAN, D. M. *Mosk. Med. J.*, 7: 48, 1927.  
 GIRAUD, J. *Marseille Med.*, 1: 229, 1930.  
 LASSEN, H. K. *Hospitalstid.*, 72: 947, 1929.  
 MICHAEL, P. R. *Nederl. Tijdschr. v. Geneesk.*, 2: 2828, 1924.  
 MOHRING, E. *Med. Welt.*, 3: 369, 1929.  
 TURENNE, A. *Rev. Med. d. Uruguay*, 29: 101, 1926.

\* Continued from p. 525.

† These papers were not accessible to us.

# CYSTS OF THE PROSTATE\*

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CYSTS of the prostate are rare, if we are to judge from the comparatively small number of cases that have been reported. To this number, I wish to add another.

This patient was a man fifty-four years of age, who complained of dysuria, frequency and straining to begin his urinary flow. His illness was of one month's duration. He voided every half-hour during the day and four or five times during the night. He had no hematuria and said his urine was clear. His general physical condition was good.

Rectal Examination revealed a prostate that was not enlarged, smooth, symmetrical and not tender.

Laboratory Findings: On admission:

Non-protein nitrogen.	50
Creatinine	2.7
Phenolsulphonphthalein	
First hour.	10
Second hour	5
After several days with indwelling catheter:	
Non-protein nitrogen	35
Creatinine	1.4
Phenolsulphonphthalein	
First hour.	30
Second hour	15

Urine analysis: negative except for a few scattered white blood corpuscles.

Flat X-ray plate, negative.

Blood pressure, 120/80.

Cystoscopic Examination: A No. 24 Brown-Burger cystoscope was easily passed; 120 c.c. of residual urine were obtained. The bladder was slightly trabeculated. There appeared to be an intrusion of the right lateral lobe with a definite sulcus at seven o'clock. The right lobe then extended over, narrowing the outlet. There was a very slight bas-fond. Practically all of the trigone was visible and both ureteral orifices appeared normal. A preoperative diagnosis of prostatic obstruction was made. A suprapubic operation was advised. This was done in the classical fashion.

Operation: The bladder was opened widely so that a satisfactory exposure of the vesical neck could be obtained. An intrusion at the upper right part of the internal meatus was seen, about the size of a large cherry which

acted as an obstruction. This obstruction transmitted the light of a Cameron lamp brightly and it was decided that the obstruction was due to a prostatic cyst. Upon attempting to remove it the cyst was ruptured with the evacuation of a viscid fluid. All this tissue was then resected away and with a Young's punch the vesical neck enlarged.

Pathological Findings: By Dr. Symmers. The resected portion was reported as mainly connective tissue, evidently pieces of cyst wall.

The patient made an uneventful recovery and was discharged from the hospital in three weeks, with no residual and no urinary difficulties. He was recently examined, sixteen months after his operation and has no urinary difficulties.

The pathology of this entity divides cysts of the prostate into three classes.

1. *Congenital Variety*: Cystic dilatation of the remnant of Mueller's duct which is the homologue of the vesicula prostatica or sinus pocularis. The utricle being a remnant of Mueller's duct has no genetic relation to the prostate gland or the seminal vesicle. Congenital defects of this organ may result in cysts. Cysts of this type are unilocular and may obtain considerable size. Spinger found two cysts of the sinus pocularis in autopsies on 62 male children who died soon after birth.

2. *Acquired Cysts*: Cysts dependent upon an obstruction of the prostatic duct with retention of secretion. Le Dentu believes these may be formed by the coalescence of several dilated aceni.

3. *Echinococcus and Dermoid Cysts*: The third and most rare group of cysts. The primary cysts of echinococcic origin in the prostate are a questionable entity but several cases have been reported which were believed by their authors to be primary infections.

The symptoms are those caused by mechanical obstruction to urination and the treatment depends on the making of the diagnosis and the variety of cyst.

\* Read before the Section of Genito-urinary Surgery, New York Academy of Medicine, April 15, 1931.



# SARCOMA OF KIDNEY SIMULATING SOLITARY CYST\*

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NEW YORK

THE patient whose history is presented was a man fifty-eight years old, when examined in February, 1930. The chief

of the lower pole of the left kidney. Injection of 20 c.c. of 12.5 per cent sodium iodide showed a dilated pelvis and enlarged blunted



FIG. 1.

complaint was constant dull pain in the left flank radiating into the groin and testis. On examination there was found a mass, globular, elastic and movable, in the left kidney area; a left varicocele with atrophy of the testis. The urine contained a trace of albumin, occasional leucocytes and erythrocytes. Cystoscopic examination revealed moderate enlargement of the lateral prostatic lobes into the posterior urethra. There was good efflux of indigo carmine from the right ureteral orifice, no obstruction or retention. The left orifice was very small, no efflux seen. After some manipulation a No. 4 x-ray catheter was passed and 10 c.c. of clear urine aspirated from the pelvis, with traces of indigo carmine.

A plain roentgenogram disclosed a sharply outlined globular shadow occupying the region



FIG. 2.

calices. The lower half of the pelvis seemed to cast a much less dense shadow than the upper half, suggesting compression by the mass. The lowermost calices while somewhat bizarre in shape presented no filling defect. The globular shadow was again visualized (Fig. 1). The diagnosis made was solitary cyst of the lower pole of the left kidney with compression of the renal pelvis and pyelectasis.

The patient was seen by Dr. A. R. Stevens who inspected the films and agreed that the diagnosis was to be seriously entertained, although some other type of tumor could not be absolutely excluded.

Operation was performed on March 17, 1930, under spinal analgesia, 120 mg. neocaine in the second lumbar interspace, satisfactory. The usual oblique lumbar incision was made, Dr. Edelman assisting. There was an unusual degree of inflammation of the perirenal and peripelvic fat. A solid tumor mass occupied the lower pole. Nephrectomy was performed. After the organ was ablated I noted a small elastic protrusion felt through the posterior muscles (psoas and quadratus lumborum) which was interpreted as a metastatic deposit. When the specimen was opened the tumor was extremely firm, greyish yellow with an area of

\* Read before the Section of Genito-urinary Surgery, New York Academy of Medicine, April 15, 1931.

necrosis and hemorrhage. Radiating fibrous strands traversed it (Fig. 2). It appeared to me to be a scirrhous carcinoma. Great was my

siderable new bone formation (Fig. 5). There were no evidences of metastasis elsewhere. Roentgenography of the chest was negative.



FIG. 3.



FIG. 4.

surprise when the pathologist, Dr. Klemperer, reported it to be a granuloma. If inflammatory, syphilis had to be considered but both Wassermann and Kahn tests proved negative.

Convalescence was uncomplicated, but the patient continued to have some discomfort in the lumbar region. On July 8, 1930, there was noted definite lateral curvature of the lumbar spine and x-ray examination revealed an area of absorption in the left upper quadrant of the third lumbar vertebral body (Fig. 3).

Deep radiotherapy was begun by Dr. William Harris and a Knight spinal brace was fitted by Dr. Seth Selig. Subsequently a mass was detected deep in the left lumbar fossa. About this time the slides were submitted to Dr. Goldzieher who diagnosed Hodgkin's disease. An x-ray of the spine November 8, 1930, showed definite compression deformity of the third lumbar vertebra (Fig. 4). I therefore concluded that the process was undoubtedly malignant. As the histological features simulated an inflammatory lesion I felt that the primary renal disease was sarcomatous. In this opinion Dr. Francis Carter Wood concurred and upon his advice transfusion and resumption of radiotherapy were undertaken.

On February 28, 1931 x-ray examination of the spine showed more marked compression of the third lumbar vertebral body but con-



FIG. 5.

A small mass may still be felt to the left and in front of the spine, and the interference with posture and gait is persistent. Secondary anemia is also present.

# THROMBOANGIITIS OBLITERANS OF THE UPPER EXTREMITY\*

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**T**HROMBOANGIITIS obliterans, also commonly known as Buerger's disease, is a disease of young or middle-aged adult males; characterized by progressive development of symptoms referable to impaired circulation locally, most prominent among which are numbness, coldness, and intense pain; and results frequently in mummification and loss of the parts affected and eventual healing in proportion to the ability of the part to establish a collateral circulation. As originally described it was regarded as almost exclusively a disease of Jews and thought to be confined to the lower extremities. More recently it is coming to be recognized nearly as frequently in patients who are not Jews. It has also been found in other parts than the lower extremities, particularly end arteries. The greater frequency in the lower extremities is probably due to their dependent position. Involvement of the upper extremities is mentioned by Buerger and Constam but the only cases in the literature of recent years in which the upper extremities were affected primarily are four reported by Constam from cases seen at the Mayo Clinic.

The following case report is that of a presumably early thromboangiitis obliterans primary in the upper extremity without involvement elsewhere:

M. Y., aged forty-four, male, white Gentile of British parentage, married, presented himself as an industrial commission case on Nov. 22, 1930. His complaint was that of numbness and tingling in the tip of the right index finger; distinct coldness of that digit; and later increasing pain until he could not sleep at night. The time of onset was rather vague but the symptoms had progressively increased during the past three or four weeks. He was inclined

to attribute his symptoms to the bruising of his finger against a milk bottle, tearing the nail slightly from its bed on the radial side with the possible entrance of a small glass fragment.

*Past History:* Always in good health. Had gonorrhea as a young man without complications other than venereal warts on the ventral surface of the penis which required removal. He had no knowledge of any luetic infection. Had had frequent examinations at his place of work including blood Wassermann tests. These tests he insisted had always been negative and we likewise received the same report from a specimen we sent to a laboratory.

He began smoking at the age of fifteen and has smoked heavily ever since. Served in the Navy as a young man. For past eighteen years has been employed at outdoor work delivering milk to retail stations. Work has consisted of handling heavy cases in the early morning hours (mentioned because of the possible significance of the fact that it is the coldest part of the day); often has abraded and bumped fingers at work. Extremities have never been frost-bitten but have gotten extremely cold on a few occasions; have required application of snow to restore normal feeling; and pain was so great that it brought tears to his eyes.

*Diet:* In the Navy, he was fed plain staple foods in a balanced ration. In civil life, he has eaten varied foods; different kinds of bread including rye, and cereals, but no one predominating or outstanding article of food.

*Marital History:* Wife living, always healthy, no miscarriages. Has four living children; always healthy, no deaths.

*Examination* showed a nervous apprehensive individual whose right index finger seemed unduly tender and sensitive out of all proportion to the visible signs. The distal phalanx appeared very slightly swollen but was not tense. A small patch about size of the flat surface of a split pea over the distal fat pad, slightly to the radial side, was dry and more cornified than normal epidermis. The possibility of a circulatory disturbance was considered quite

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strongly but in order to give full weight to his claim of injury, the possibility of an infection also had to be entertained and so moist bichloride dressings were applied.

The pain was not relieved and three days later a slight serous discharge just to the radial side of the nail suggested a foreign body reaction. Under local anesthesia, a small longitudinal incision was made just lateral to the nail margin but no foreign body or evidence of infection was found.

Under subsequent treatment with moist bichloride dressings and then ammoniated mercury ointment dressings, the distressing symptoms subsided but the wound remained indolent. There was never any suppuration; only a dark necrosis of the wound edges. After about three weeks the wound was left dry and mercurochrome applied but an exacerbation of pain occurred on Dec. 24 of such severity that opiates were necessary for relief. On Dec. 27, an x-ray examination showed that the greater part of the distal phalanx had been absorbed and that an isolated small sequestrum was present under the lateral margin of the nail. This sequestrum came away about two weeks later and prompt healing followed. He was last seen for that illness on Jan. 31, 1931. The wound was healed with loss of substance on the radial side of distal phalanx and retraction from the lateral margin of the nail. The epidermis of the finger end remained very dry and horny.

On March 3, 1931, the patient returned complaining of intense pain in his right middle finger. He attributed his condition to an indefinite injury which he placed at about Feb. 25. There had again been distressing paresthesias along with the pain. He had resorted to home remedies without relief.

Examination showed an edematous swelling of the distal half of the right middle finger with an eczemoid lesion about the nail characterized by brownish scales and exudation of serous fluid. There was distinct paleness and coldness of that digit.

It was now felt with more certainty that this was a circulatory disturbance of the nature of a thromboangiitis obliterans. However, the alleged trauma could not be disregarded. Wet dressings of Dakin's solution were applied and abstinence from tobacco urged. This had previously been suggested to him but this advice was never very faithfully carried out.

The pain and sensitiveness to touch remained so that he was unable to work. He required

opiates in order to get any sleep. Most of the month of March he was compelled to sleep sitting up in a chair, often finding it necessary to hold his hand up above his head for relief. On March 10, the tip of the finger and the nail bed had become definitely gangrenous. His blood pressure on that day was 130/80. Dressings with an ointment containing butesin picrate were resorted to and gradual improvement followed. A definite line of demarcation developed and by the end of March most of the swelling was gone and the pain was very much less. A black slough developed, liquefied rapidly, and disappeared. At the end of April, the wound was dry with the end of the terminal phalanx protruding but still firmly attached. Only a small corner of the nail remained and nearly all of the nail bed was gone. The patient returned to work May 5 and after about one week some discharge appeared about the exposed bone. This bone became detached so it could be removed on May 19. Prompt healing followed. Only small crusts and parts of the nail came away for the few days we continued to see the patient. When the patient was last seen about two and one-half months later, both fingers had quite serviceable ends and quite a good deal of regrowth of the nail and nail bed of the middle finger had occurred.

During the course of the last illness, careful external examination failed to reveal any evidence of a cervical rib which might be productive of a trophic disturbance. To tactile sensation, both the radial and ulnar arteries appeared to pulsate with undiminished force at the wrist. The urine analysis was negative on two occasions.

*Summary:* A middle-aged adult male, a Gentile, appeared with symptoms of impaired circulation in the right index finger thought to follow what would be an inconsequential trauma to the usual individual. The outstanding feature was severe pain. The process went on to gangrene of the terminal part of the finger with prompt healing following loss of substance. This process was repeated soon in the middle finger. No evidence of arteriosclerosis, lues, diabetes, or other source of trophic lesions was found. Hence we conclude that clinically this was a case of thromboangiitis obliterans primary in the upper extremity.

# CHOLECYSTECTOMY

## A REFINEMENT OF TECHNIQUE\*

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**A**MONG the various factors which may result in successful surgery, we are concerned today with the minimum of operative trauma, proper peritonealization of raw surfaces and refinements in ease and speed of procedures. The method of serosal dissection in cholecystectomy as described later offers this triad and is applicable wherever the serosa overlying the gall bladder is not densely agglutinated to the underlying tissues.

Suitable exposure having been made, the gall bladder brought into the operative field and the duct clamped in the usual manner, a solution of normal saline is injected subserosally at the fundus and downward bilaterally in the line of usual incision. A long fine curved needle of very short bevel will be found most advantageous. As the serosa lifts in response to fluid pressure, the point of the needle is advanced along the line of subsequent incision; it will be found that the serosa is well lifted from the muscularis in the line of incision and that the greater part of the serosal dissection has been done by the fluid thus injected. The serosa is then picked up, snipped, and the incision down both sides and over the fundus is easily accomplished with scissors.

This method of dissection of the serosa may be carried out with the duct clamped or not, but is of course done with greater facility if the duct has been previously clamped. Obviously, if the gall bladder is half-empty, the muscularis will be displaced to the interior of the gall bladder more than the serosa is lifted. If the gall bladder wall is under the tension of the contained bile, the serosa is ridged up prominently along the line of injection, since the greater the pressure within the gall bladder, the greater the hydrostatic power of the subserosally injected solution.

This method will be found to offer the following advantages:

1. The serosal dissection is done to a great extent by the injected fluid, and trauma from instrumentation is therefore at a minimum.

2. There is practically no danger of the interior of the gall bladder being invaded in any subsequent necessary dissection, since the serosa is already lifted.

3. Very even serosal margins are offered for peritonealization of the gall-bladder bed.

4. Since serosal dissection is tedious and time consuming, this method offers ease and speed of procedure, with a wide margin of safety.

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### REFERENCES OF DRS. HEARD AND ABRAMSON\*

1. BLOODGOOD, J. C. *Lewis' Practice of Surgery*. Phila., Vol. 4, Chap. iv pp. 129-132.
2. GORIS, M. J. *de Chir. et Ann. Soc. Belge de chir.*, 5: 395-398, 1905.
3. LEARMONTH, J. R., AND KERNOHAN, J. W., *S. Clinics N. America*, 11: 853-865, 1931.
4. MORGAN, J. H. *Trans. Clin. Soc. London*, 23: 265, 1889-90.

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

## EDITORIALS

### ANESTHETIC PROGRESS BY INTEGRATION

WITHIN the last six months, a personal inquiry was addressed to the Surgical Directors of fifty-three of the leading hospitals in Greater New York, with a view of securing light on the following facts relating to anaesthetic service. These hospitals in this metropolitan area furnish, it is felt, a fair cross-section of the hospitals throughout the country, for the reason that this group is more or less free from the influences which give rise to so-called gas sections on the one hand, and open ether sections on the other. The inquiry was couched in the following broad terms, asking information concerning three groups of facts:

"In your employment of general anesthesia for abdominal surgery, upon what technique do you largely depend—spinal or general anesthesia?

"If general anesthesia, what is your chief anesthetic agent, ether, gas oxygen, or ethylene?

"Have you found it desirable to use preliminary medication, such as morphine, atropine, sodium amytal, or avertin?"

Forty-one replies were received to these fifty-three inquiries. A fairly large percentage indicating considerable general interest.

In reply to the first question, 4 surgeons reported their chief dependence upon

spinal anesthesia; 35 used "general," and 2 showed no preference.

In round figures, 10 per cent depended upon *spinal*, and 90 per cent upon general anesthesia.

In answer to the question: Upon which agent do you chiefly depend? 2 were in favor of ethylene, 3 gas-oxygen, 3 gas-oxygen and ethylene, 2 institutions made a practice of using gas-oxygen with a little ether, 19 preferred the gas-oxygen ether sequence, and 10 institutions were in favor of ether. The hospitals reporting a preference for spinal anesthesia did not express a choice for a general agent. To summarize, 5 per cent preferred ethylene, 15 per cent gas and oxygen, and 80 per cent felt that they were better off with more or less ether for their abdominal surgery.

Referring to the use of preliminary medication of the 37 who reported: one used no medication; 2 preferred avertin; 4 used morphine, atropine and avertin; 5 used morphine, atropine, and sodium amytal; one used scopolamine; 6 used morphine; and 17 used morphine and atropine.

To summarize, approximately, 97 per cent used preliminary medication; of this percentage, 35 per cent made use of the newer basal anesthetics—sodium amytal and avertin. The larger number, however, employed the customary preliminary morphine with or without atropine.

In view of the conclusion to be drawn from this inquiry; namely, that 90 per cent of abdominal surgery is done with general anesthesia, in approximately 80 per cent of which general anesthesia ether is employed, preceded in almost every instance by preliminary medication, may we not properly inquire: Does instruction in ether anesthesia and a knowledge of its action correspond with the popularity of its usage? Should we concentrate upon instruction directed to better, safer, ether anesthesia, or should we look upon this usage, as typical medical ultra-conservatism, devoting our energies, therefore, to

the elimination of ether as a general anesthetic?

The writer believes that there is a strong tendency to follow, or shall we say, retain, the gas-oxygen ether sequence in abdominal surgery. Whether this tendency is due to an ignorance of the value of the newer anesthetic agents and sequences, or whether it is the result of the unfortunate experimental use of agents which have been proposed as panaceas, is a question which has not been answered. Furthermore, are the conclusions arrived at based upon the findings of a specially trained and selected personnel, or upon the service rendered by anyone in the house who happens to be able to give an anesthetic?

These questions and others would have provided a questionnaire of valuable content, but practically useless, since, human nature being what it is, these questions would not have been answered.

Upon the facts presented, however, may we not propose a thought, a watchword, a point about which substantial and legitimate improvement in anesthesia may turn? May we not apply to the disorganization in anesthesia which we see about us the sound philosophy of integration; the orderly accumulation of knowledge and experience, and its universal and practical application; in contradistinction to the continual and wholesale elimination and substitution of the tried and the true which has come to be looked upon as medical progress.

Hundreds of thousands of anesthetics administered and studied during the last ninety years have made available a body of knowledge which must be respected and in justice consulted in estimating the real value of new agents and methods of administration. In the absence of this fundamental knowledge, we are entirely at the mercy of any force or group proposing a new agent or a new method.

Without a knowledge of the clean-cut, fundamental requirements of good anesthesia, in their normal sequence of safety, efficiency, and freedom from unpleasant

effects, we cannot be expected to make and to encourage the sacrifice which a rational choice entails. We will either fall into the error of sacrificing safety for the surgical ease of the routine spinal anesthesia (post-mortem abdomen), or, we will yield to the patient's plea for the minimum postoperative discomfort, reducing thereby the margin of anesthetic safety, and working against rigid muscles and active reflexes.

No one, of course, objects to the prudent employment of newer agents and methods where definite indications present themselves. It is the naive adoption of extremes as an institutional routine to which exception is taken.

If it is true, as stated by Miller, that it is unlikely that a healthy patient has ever lost his life from ether properly administered, it is doubtless true also that any other anesthetic administered with the gross negligence with which ether has been administered would long since have been discarded; and if it is also true that the long use of ether has enabled us to become better acquainted with it than with any other anesthetic agent, is it not of fundamental importance that these facts be recognized in the management of our anesthetic services? Does it not follow that, as a fundamental requirement to anesthetic instruction every one should be taught ether anesthesia?

Upon the solid basis of safety and efficiency raised by time and experience, we may safely and with profit integrate the newer facts of anesthesia. We may then use our available gases, nitrous oxide, oxygen, ethylene, and carbon dioxide; our basal anesthetic agents, morphine and atropine, scopolamine, sodium amytal, avertin, and pernocton; our local and spinal methods, with novocaine, nupercaine, and the other drugs available.

Integration makes use of the personnel administering anesthetics. In well-organized medical groups, with a large volume of material susceptible of routine treatment, the technician is useful and safe. Intelligent

direction and responsibility for the anesthetic, the practical integration of all the facts of a given case, may here be adequately met and safety preserved by the operating surgeon; for medical judgment, direction, and legal responsibility are neither sought nor desired by the technical group. The employment of a nurse to give an anesthetic presupposes an intimate knowledge of anesthesia on the part of the surgeon.

The man who makes use of technical assistance outside of a large well-organized institutional group must be trained to meet his responsibility for the correct choice of agent. He must have a knowledge of its action and be prepared to direct treatment in emergencies. In the absence of such information, he is obligated to protect his patient by providing this service.

The integration of anesthesia involves also all forms of instruction, that to the surgeon, medical student, interne, general practitioner and nurse. It directs the course of research and experiment. Its conclusions are made upon a basis of justice to the patient, the surgeon, and the anesthetist, prudence in the approach to risks, a temperate enthusiasm for untried agents, and a steadfastness in doing what is right, regardless of opposition or reward.

It is well to keep constantly before us the fact that a drug which will destroy consciousness, muscle tone, and reflexes, is a dangerous drug; that its use as an anesthetic agent does not reduce this danger, but increases it, and that its employment by a surgeon for 5000 operations without a death should not satisfy us that it is safe in other hands, and under other conditions. It may therefore be reasonably concluded that if the hoped-for ideal anesthesia were discovered tomorrow, it would be forced to prove itself over years of use.

May we not, therefore, with profit turn our attention, as we strive for improvement, to an evaluation of our present possessions?



Is it not incumbent upon us to provide facilities for serious instruction in anesthesia; to provide adequate training in anesthesia for the medical student, interne, general practitioner, nurse, and last, but by no means least, the surgeon who employs and depends upon the services of a technician?

The first step in the training of the student is a recognition on the part of the medical schools and the hospitals of the dignity of anesthetic obligations, the recognition that this practice is the most critical and dangerous branch of therapeutics. Following this improvement in morale, may we not insist that a knowledge of ether be acquired before the student makes use of the gases, the basal anesthetics and the available local methods?

For the men who have completed their student days and who are now practicing surgery, instruction should be available in the form of post-graduate information, presented with a dignity, an understanding and a maturity of viewpoint in keeping with the experience of the man seeking instruction.

In conclusion, therefore, it is suggested that true improvement and progress in anesthesia can best be achieved by integration; by the correlation and practical application of anesthetic knowledge and experience in its correct sequence.

As a primary means of affecting this integration, an attempt should immediately be made to improve the standing of anesthesia as an art. Adequate and serious instruction should be planned, and should be provided for the medical student, interne, general practitioner, nurse and the uninstructed surgeon who makes use of technical assistance.

PALUEL J. FLAGG.

#### NOTICE

At a recent meeting and examination of the American Board of Obstetrics and Gynecology held in New Orleans on May 10, 1932, fifteen applicants were accepted for certification. Three failed to obtain the required grades.



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NATHAN SMITH

[[1762-1829]]



## AMERICAN PHYSICIANS NATHAN SMITH

**N**ATHAN SMITH was born in Rehoboth, Mass., September 30, 1762.

He was "one of the great pioneers of American medicine, and during his active life was the omnipresent genius in New England medicine."

He taught in the local rural school. During this time Dr. Josiah Goodhue of Vermont visited the neighborhood to amputate a leg and Nathan acted as a lay assistant. This awoke a desire to study medicine. The Reverend Whiting of Rockingham, Vt., became his tutor. In 1784 he presented himself to Dr. Goodhue as a private student and remained three years. At the age of twenty-five he began to practice (1787) in Cornish, N. H., without a medical degree. He attended several courses of lectures at the Harvard Medical School and received his degree of Bachelor of Medicine (1790), the fifth student to graduate from the Medical School in the third class of that school. His M.D. was conferred on him automatically in 1811.

In 1791 he married Elizabeth Chase. She died in 1793 and the next year he married her half sister. Two sons were born of this marriage.

While practicing in Cornish he was impressed with the meager facilities for medical education. In 1796 he attempted to start a medical school at Dartmouth Col-

lege, but failed. Smith then went abroad and studied in Edinburgh and London. Soon after his return in 1797 he was awarded a diploma from the Medical Society of London. He also became a corresponding member.

In the Fall of 1797 he delivered the first course of medical lectures at Dartmouth. In August, 1797, the trustees established a medical department with Smith as professor of anatomy, surgery, chemistry and physics. Oliver Wendell Holmes said it was not a chair but "a whole settee of professorships." Thus the fourth medical college in the United States was founded. In 1821 he was asked to establish a medical department at Yale. He accomplished this in the face of many obstacles. He did the same for Bowdoin College (1820) and later for the University of Vermont.

He was never a voluminous writer, although his essay on typhus fever (1824) and his observations on necrosis (1827) are still memorable.

He operated for amputation of the knee joint, performed the second ovariectomy in the United States, and did the first staphylorrhaphy. But he will be known as a great teacher and organizer.

He died at the age of sixty-seven years in 1829.





[From Fernellius' *Universa Medicina*, Geneva, 1679.]

# BOOKSHELF BROWSING

## THE INTERESTS OF A UROLOGIST IN 1880\*

EDWARD L. KEYES, M.D., F.A.C.S.

NEW YORK

**B**ERGSON has called attention to the profound fact that in life and thought as in time there is no such moment as now and in particular that the crystallization of our thought in words kills it. Many think the same is true of art and seek the sketch rather than the finished product, feel indeed that Michael Angelo showed himself almost unique in the wisdom that bade him stop his work where inspiration ceased.

Yet even in writing there are moments which are sketch-like and share the eternal vitality of the artist's sketch. Such items present the momentary interests of the author's mind and here it will be a pleasure at least to the writer of this paper to transcribe, with an egotism which he hopes may be found pardonable, the notes contained in an interleaved textbook in his possession which was being made ready for its second edition by the author just fifty years ago.

The book which is our text is entitled, "A Practical Treatise on the Surgical Diseases of the Genito-Urinary Organs, including Syphilis. Designed as a Manual for Students and Practitioners, by W. H.

Van Buren, A.M., M.D., Professor of the Principles of Surgery, with Diseases of the Genito-Urinary System and Clinical Surgery, in Bellevue Hospital Medical College; Consulting Surgeon to the New York Hospital, The Bellevue Hospital, The Charity Hospital, etc.; and E. L. Keyes, A.M., M.D., Professor of Dermatology in Bellevue Hospital Medical College; Surgeon to the Charity Hospital Venereal Division; Consulting Dermatologist to the Bureau of Out-door Relief, Bellevue Hospital, etc." This is the first edition, published in 1874.

The annotations are in the hand of Keyes and seemingly written in the late 70's or about 1880, judging from the dates of the authors cited.

There is but one exception, signed "V. B.," which reads as follows:

In a gouty man of 66 from whom I removed a vesical calculus by lithotripsy after much complaint of local pain, at first recorded as lumbago, fluctuation was detected over the right kidney behind. After exploration\* it was opened and a moderate amount of thin pus escaped with relief from the pain. A fistulous opening

\* Presumably with a trocar.

\* Dr. Keyes read a chapter on "Early Urology in New York" from a forthcoming book to be published by the American Urological Association, before the New York Society, Feb. 24, 1932. To this he adds the following comment. Ed.

remained for some weeks. Within the year he died with symptoms of uremia from Bright's disease. H. Munsell attended him with Lente of Cold Spring in 1871.

Of the multitude of notes in my father's handwriting it seems appropriate to give only a few selected examples to show the state of mind of an inquiring urologist on certain topics at that date.

Of first importance in those days was infection as is illustrated by the following quotation.

Pasteur who maintains that without bacteria urine does not decompose, overthrew (*Comptes rendus de l'Acad. des Sci.*, July 23, 1877) Bastian's experiments, showing that the fallacy of the latter consisted in his not having purified his flasks by heat. The liq. potassae, the urine and the flasks must be so purified to make an experiment valid. Pasteur and Joubert (*Journal de Pharmacie et de Chirurgie*, Sept. '76, 206) repeating some experiments of Musculus prove that the soluble ferment procured by the latter from ammoniacal urine which is capable of changing urea and water into carbonate of ammonia, is the product of bacteria since ammoniacal decomposition does not occur without the latter.

P. Cazenave and Ch. Livon ligated a dog's prepuce, allowed bladder to fill, then killed dog and tied ureters and urethra. Bladder was removed and kept exposed to air for several days at temperatures varying from 80° to 122°F. The experiment was several times repeated but organisms did not appear in the urine whatever its original reaction had been nor did it decompose. (The urethra is full of bacteria—Keyes.)

The following quotation illustrates the difficulties that beset the practical mind in determining the importance of bacteria in infection of the urinary organs.

Moreover bacteria may exist in bladder and not create cystitis or ammoniacal changes in the urine at all. During winter and spring of 1878 I kept unprotected on my office table for six (at least) months very acid urine, loaded with pus, passed like gruel from a child with pyelitis. I frequently opened and examined the bottle and although bacteria developed in it abundantly (active rods, etc.) no ammoniacal

changes occurred, the urine did not decompose, the pus did not become gelatinous. I have several times had patients who habitually passed phosphatic urine (earthy) containing bacteria (but no pus) in whom there was no cystitis whatsoever.

At that period too the sharp reaction to the passage of urethral instruments in patients who had suffered grave impairment of kidney function was poorly understood. Here, for example, is a paragraph which illustrates the confusion of mind produced by the suggestion that bacteria are the cause of urethral chill.

Gosselin while adhering to the inevitable "absorption urinaire" so loved by a Frenchman inclines to the belief that the absorption of the bacteria of decomposing urine may have something to do with the deadly result as well as the carbonate of ammonia to which he ascribes a large influence. But urinary absorption will not account for the strange exceptions which are so much more numerous than even the rule.

At this very time the proof that gonorrhea is a specific disease was advanced by Neisser.

The latest attempt to explain the quality of the contagium of gonorrhoea is that of A. Neisser who in *Centralbl. of Med.*, Nov. 28, 1879, describes a peculiar micrococcus which he likens to sarcina and believes to be the cause of the disease.

Yet very probably the following note was made subsequently to the preceding one. It is to be particularly observed that no judgment is passed upon Dr. Morrow's observations.

An excellent article dealing with the question, "Is there a specific urethritis?" very ably argued and answered in the negative, appears in the *New York Medical Journal* for September 1881, p. 263, from the pen of Dr. R. A. Morrow. He quotes the experiment of Vetch who produced gonorrhoea by inoculating muco-pus from Egyptian ophthalmia—but the gonorrhoea appeared in 36 hours. Guyomar inoculated his own urethra from granular purulent ophthalmia—the results appeared on the third day, and got well after three weeks (a poor

gonorrhoea). Other similar experiments are cited.

Pauli de Laudau provoked urethritis in a man by pus from ophthalmia neonatorum, the man transmitted the disease to his wife. A. Hillier inoculated his own wife from his own urethritis produced mechanically. Otis reports a similar case.

He quotes De Luca's experiments with women showing that pus from the most varied sources injected into the urethra of a female may produce a discharge "absolutely similar to that of venereal origin." He states that "pus from urethritis applied to the eye will produce ophthalmia, pus from the conjunctiva applied to the urethra will produce urethritis." He then cites Panuus and the names of Jaeger Piringer, Van Roosbroeck Warlomont, Desmarres, Richard, to prove that the effect is the same whether pus is taken from the eye or the urethra. In Piringer's 87 cases, in 2 the pus came from the urethra of a boy  $3\frac{1}{2}$  years old. It is claimed in these cases that the difference in effect varies directly with the intensity of the process yielding the pus.

In the early '80's also Simon had just done his first successful nephrectomy and the interleaved pages of this volume overflow with case reports and statistics on what might be termed the elements of renal surgery.

An early method of timid nephrolithotomy is illustrated by the operation of Petersen who tapped a pyonephrotic kidney with a cannula, dilated the wound with laminaria tents and then introduced a lithotrite and crushed the stone. The patient recovered, the fistula remained open.

An early attempt at ureter catheterization in women is that of Simon who dilated the urethra sufficiently to admit the finger by which the ureteral orifice was identified and a catheter passed.

An extraordinary treatment for hydro-nephrosis was employed by Billroth. He first drew 1900 c.c. by tapping through the abdomen for ascites. Urea was found in the fluid so seven weeks later the refilled sac was evacuated in the same way and "24 grams of Austrian tincture of iodine with

equal quantity of water injected and allowed to remain five minutes, then partly withdrawn. This injection was repeated in three months and the patient is reported as dismissed cured four months afterward."

No notes are added to the page devoted to discussion of renal tuberculosis but a great number of nephrectomies are reported, notably Barker's paper (1880) which records 29 nephrectomies with 15 deaths, the first by Wolcott of Philadelphia in 1861. Simon's case (1869), the first recovery, is of course extensively commented upon.

It took bold surgery to contemplate nephrectomy without any assurance of the presence of the opposite kidney as the many deaths amply attest. Yet by 1877 Hayes had recorded 16 successful nephrectomies, one in a child two years old.

But the grave preliminary experimental work which led Simon to his successful operation was not universally copied in those days any more than it would be today.

It is often forgotten that at the time of which we are speaking suprapubic cystotomy was absolutely taboo because of the frequency and gravity of the septicemia which complicated operations upon the bladder "above the bone." Hence the quasi-unintentional attacks upon the enlarged prostate were made by the perineum.

A. Berti broke male blade of lithotrite on a large stone in bladder of 73 year old man. He then cut (lateral) and on account of enormous size of prostate could do nothing. He then tore off the enlarged central hypertrophy and cut out stone and instrument. Patient recovered (1880).

Bottini, of Pavia, has devised two instruments for destroying third lobes, etc., by galvano-cautery, made like a Mercier catheter and Mercier prostatome. He claims to have used it to great advantage.

C. Heine claims to have considerably reduced the size of enlarged prostates by accurate measurement by parenchymatous injection of iodine. He injected about 5 drops of tincture of iodine in water with a little over  $\frac{1}{2}$  grain of pot. iod. making an injection into each hypertrophied lobe. He reports experience in

six cases, all old men, and got improvement in all cases not only in reducing severity of symptoms but also in diminishing size of organ notably by actual measurement. Abscess formed only in one case and generally there was no disagreeable reaction whatsoever—some heat and smarting on urination were noticed.

Dittel has produced acute prostatitis with suppuration by the employment of Heine's method.

Outstanding growths may be cut or torn away during other operations (as for stricture or stone). Bryant has recently reported some successful cases to the *London Path. Soc., Med. Times and Gaz.*, Feb. 16, 1878. Sir W. Fergusson, *Med. Times & Gaz.*, April 16 and May 23, 1857, relates that in operating for stone he found a pedunculated prostatic overgrowth as large as a pigeon's egg which he removed (the patient died) and he refers to a case shown some time before by Sir William Lawrence at St. Bartholomew's wherein a solid whitish tumor presented, after cutting through the prostate as at stone operation, which was removed. This was doubtless one of those central tumors which shell out so easily after cutting into their surrounding tissues. (Look up.)

In contrast with such feeble attempts at operative removal of the large prostate the general results of palliative treatment by the catheter seemed worthy of consideration.

Sir H. Thompson stated at a meeting of the Royal Medical and Chirurgical Society, at which I was present in May, 1879, that he knew a gentleman aged 90 who had passed the catheter during 22 years, while a gentleman of Norwich told him that he had used the catheter upon himself 35,000 times. He (T.) had made some investigations with Dr. Messent upon the old men in Greenwich Hospital and found that while the average death rate there was 73 years, the average of those who used the catheter was  $72\frac{3}{4}$  years, a very excellent showing of the harmlessness of the use of the instrument.

And now enough has been said. We may profitably close with the quotation of a few curious conditions and suggestions taken at random from various parts of the book.

Dr. W. J. Love of Wilmington, N. C., has reported a case where the same patient on two occasions at an interval of six years was relieved by spontaneous ulceration of a (urethral) calculus through the perineum. One of the stones is said to have weighed over 500 grains.

McGregor. Extraordinary case of urinary calculi, *Am. Jour. Med. Sci.*, January, 1877. Woman 63, had passed several hundred calculi in four years. Search revealed empty bladder and an number of stones (apparently) encysted. The cyst wall was cut and some stones extracted, but a stone too large to remove was felt and the operation terminated. Peritonitis. Death. Autopsy showed calculous mass in displaced kidney which rested on bladder. From this kidney there were removed on section 520 calculi of small size and one large stone weighing 51 ounces, measuring  $5\frac{3}{8}$  inches in length and  $16\frac{5}{8}$  inches in greatest circumference—apparently (not cut) uric acid.

Le Dentu presented to the Society of Surgery, Paris, a prostate containing a vast unilocular cyst as large as a small mandarin orange due to dilatation of numerous prostatic glands and subsequent disappearance of their walls. It contained a tenacious fluid and no pus and communicated with the prostatic urethra by a number of minute orifices.

William A. Hammond says, *St. Louis Courier of Med.*, May, 1880, that he has treated two cases of neuralgia of the testis, one of which was of long standing, successfully by crushing the nerves of the cord for a few minutes at a single sitting. An instrument like a lemon squeezer is recommended, the blades of which may be brought together by a screw. The cord is tightly compressed for several (5) minutes, the pressure is intermittent to allow circulation to be resumed, the pressure is again applied. The pain ceases as does also the common sensibility of the scrotum and testicle but these latter return after some days while the neuralgia remains cured.

A personal recollection of the impression made by Paul Segond's remarkably lucid presentation of the subject of prostatic abscess is the excuse for copying the summary of his statistics found in these pages.

A case of Guyon's is alluded to where prostatic abscess followed an abortive injection



used to prevent possible infection in which fear caused the patient, an old man of 50, to push the injection deeply into the urethra. Death from purulent infection followed in a few weeks.

Ambroise Pare's Abbe is referred to who after a dose of cartharides died with gangrene of the penis.

In an analysis of 77 cases of peri-prostatic suppuration the pus escaped (aided or unaided)—

- 64 times by the urethra
- 43 times by the rectum
- 15 times by the perineum
- 8 times by the ischio-rectal fossa
- 5 times by the groin
- 2 times toward the obturator foramen
- 1 time by the umbilicus
- 1 time by the great sacro-sciatic notch
- 1 time at the border of the false ribs
- 1 time by the peritoneum
- 1 time by diffusion, the pus reached the pre-peritoneal cavity of Retzius.

Faucon and Peter have published cases of peritonitis due to peri-prostatic suppuration.

Does it not whet your curiosity to know the history of those abscesses that discharged at the border of the false ribs or by the umbilicus?

And is it not equally stimulating to one's curiosity to encounter the following note.

Possibly peri-prostatic abscess may owe its origin to suppuration in one of the chain of lymphatic glands lying between the base of the prostate and the rectum. Lannelongue has described these glands (six in number) between the base of the bladder and the rectum. He found them enlarged and inflamed in an autopsy of a boy who died with tuberculization of the prostate, seminal vesicles, right ureter and kidneys.

#### DISCUSSION

DR. COLIN L. BEGG: In looking over old files preparatory to discussing Dr. Keyes' paper on the beginnings of urological history in New York, it occurred to me that some details of the inception of the Association coming from one of the few remaining founder-members of the American Urological Association might possibly be of interest.

Those of you who have not had the pleasure of knowing its founder and first president,

Dr. Ramon Guitéras, can have but little idea of the great privilege associating with him professionally and socially, meant. Nobly born, properly schooled, much traveled, an excellent linguist, he possessed a personality which was incontrovertible. Tall and athletic, commanding in appearance, but having withal the kindness and simplicity of a child, he was at home alike in the courts of Europe, charity hospital ward or East-side tenement. His keen sense of humor, gracious Latin temperament, and his excellent command of English made him a prime favorite as a speaker and warranted full attendance at his lectures.

After the close of these lectures and clinics held at Post-Graduate Hospital on Tuesday, Thursday, and Saturday evenings, it was a frequent habit of "the Chief," as we called him, and us his associates to dissolve into social session and, utilizing a Continental custom, repair to some pleasing cafe or restaurant to discuss the cases of the evening. Often, because of propinquity, we would go to Sheffield Hall on 17th Street, where Wurzburger was at its best; or Lüchow's on 14th Street, where Pilsner and Münchner were prime; or the Cafe Boulevard on 9th Street, famed for its Hungarian dishes; or Moquin's on 28th Street, with its delightful French cuisine.

Thirty years ago, on the evening of day before yesterday, February 22, 1902, the Chief suggested that we try a new place on 11th Avenue in the 50's, where it was rumored there was to be had good Austrian wine. It was named the "Sieben Schwaben." There we went and discussed the advisability of founding in this country such an association as the French possessed in the "Society of Urology." After due motion and due seconding, the American Urological Association was founded, with Dr. Guitéras as its first President.

In such humble and delightful surroundings the birth of this Association, of which we are the New York Society, took place. In the early months the membership was mainly local, but gradually this was increased to such an extent that branch societies were found necessary, so that today eleven such branches are in existence in the United States and Canada; and the active and honorary members comprise many of the outstanding urologists of the world.

DR. EDWIN BEER: It is always very interesting and often amusing to reminisce. Dr. Keyes

has presented in a most entertaining manner the development of urology in New York City.

This seems to come at a particularly appropriate time, when the French are celebrating the centenary of Félix Guyon, whom they acclaim as the "Father of Urology." Many of us are greatly interested in Guyon. We know his work; we know his many contributions to this branch of surgery. Many of us would have been disappointed if Guyon had been substituted for Nélaton, surgeon to Napoleon III during the Franco-Prussian War (as Legueu tells us very nearly happened). If Guyon had been recognized as the proper man to take care of Napoleon's bladder stone, the battle of Sedan, he claims, would have been a French victory and the World War never fought, no Alsace-Lorraine question—a very fortunate thing for the rest of the world. Napoleon III could not ride horseback with a stone in his bladder. The story goes that the army was defeated by the Prussians and Napoleon taken prisoner because of the slow progress of his horse and victoria. If the "Father of Urology" had had his chance, the stone would have been taken care of and no World War would have taken place. This demonstrates the importance of modern urology. Yet it is interesting to note that a man as keen as Guyon could fail to recognize prostatectomy as a feasible procedure; that he believed that anyone who did it could be considered a murderer (as he probably would have been in those days). He came out flat-footedly against it.

Another remarkable mistake of his was in connection with renal tuberculosis. He said it was a disease which affected the whole urinary tract, genital as well as kidneys and it took many years before James Israel of Berlin was able to persuade the medical and surgical profession that nephrectomy would cure it. And we all know it has provided such a cure to 65-80 per cent of those suffering from it.

Although I have not been so fortunate as Dr. Keyes in his heritage of the Van Buren, Gouley and Senior Keyes traditions, I can very well remember that master surgeon, Charles McBurney, and his lateral approach to the bladder. It was in those days a most mysterious procedure to see him go in through the lateral perineal route and in less than five minutes deliver a stone by forceps. It seemed in a class with necromancy.

Dr. Keyes spoke of the early use of iodine in the prostate. In the German literature mention is made even now of iodine introduced into the prostate in cases of hypertrophy. It is used in a great many clinics, and highly recommended as Pregl solution.

Tonight's reminiscences recall to me one of the early surgeons whom I happened to have come in contact with and who considered himself a urologist, Dr. Fluhrer. In his day he ran a service in two or three hospitals, including Mount Sinai, as a genitourinary specialist. It was most amusing to see his work on the urethra. When he got above the prostate, he was absolutely lost; but in the urethra, as far as instrumentation was concerned I do not think there ever has been anyone who was quite so meticulous in whittling down whale-bone bougies, and in twisting and cutting them to suit his purposes. I remember well a ward where he was trying to whittle down one of these bougies. He would stop work if a door was slammed or any noise made until there was absolute silence as he worked. He was a most determined man, so much so that he insisted upon being operated upon for appendicitis, although he had a ureter stone. The ureter stone was palpated at the time of operation, and he passed it a week later.

One day, in the operating room, he passed a sound. This was in precystoscopy times, as only the general surgeon, strange to say, was doing cystoscopy then. He encountered a click. He said, "Ah, a stone," and tried again and again to repeat that click, until the anesthetist advised him that his patient was very ill indeed. He had been under anesthesia for forty-five minutes or more during this procedure. Then Dr. Fluhrer decided to go in from above. Instead of finding a stone he found an enormous encrusted carcinoma. The patient died of ether pneumonia.

In the early days every surgeon had his own urethrotome. Apparently all efforts were directed against the urethra. There was Otis' urethrotome, Maissonneuve's, Gerster's, Lange's, etc. Fortunately few of these instruments are in vogue now, all having been quite properly junked or given to museums.

That early note Dr. Keyes read about acid urine remaining sweet and clear was very interesting. There is no doubt that most of us, in our hurry nowadays, have not profited by some of the experience of those who have gone

before us. Acid urine will remain absolutely uncontaminated for many months (six or seven); and our attention is often directed to the fact that it remains not only hyperacid but is full of uric acid crystals. It brings up again the old question of uric acid shower colics. I have mentioned this repeatedly before this and other societies, recently. When Dr. Braasch was here he told me that he made a practice now of letting urine stand for several days (as did our predecessors) in his search for uric acid crystals and in an attempt to correlate his findings and the symptoms of colic. The older practitioners regularly proceeded in this way, and the moderns have not followed in their footsteps.

DR. J. STURDIVANT READ: The subject of Dr. Keyes' paper of this evening suggested to me to investigate what was happening in my own hospital in the early '60's. The Medical Department of Long Island College Hospital was functioning well by 1860, and constant references show that the surgeons in Brooklyn at that time performed the genito-urinary surgery of that day.

The first formally appointed professor of surgery and lecturer on venereal diseases seems to have been in 1873, Dr. George K. Smith; from 1882 to 1884, Dr. George H. Atkinson; from 1885 to 1895, Dr. Henry Walter Rand occupied the chair. In his own handwriting I find the record, "lecturer of diseases of the genito-urinary organs, 1885, and clinical professor of diseases of the genito-urinary organs from 1886 to 1895." Dr. Henry Morton succeeded Rand. It was due to Dr. Morton that the full importance of urology as a separate branch was recognized and established in our institution. His contributions are too well known to all of us to need any mention, and I only wish to speak of the earlier men, Dr. Smith and Dr. Rand.

Along with Otis' belief in cutting strictures in the anterior urethra (which by the way is still a good procedure), Smith had an equally confirmed faith in meatotomy. He believed it would cure all the ills that flesh is heir to. He did meatotomies for everything; and incidentally probably cured some things which could not be handled in any other way. I was talking with two of his contemporaries recently about Smith, men who knew him well, and they told me the following stories:

It seems he was called to see a desperate case of pneumonia one day. So sold was he on the idea of meatotomy that he immediately prescribed this procedure, after which he remarked, "See, he breathes better and more vigorously than before."

The other story was probably the highlight of his career. Smith used to drive around Brooklyn behind an old white horse. One day it balked in front of the hospital and refused to move. He climbed out of the carriage, did a meatotomy on the horse, and henceforth proceeded to drive all over Brooklyn without difficulty.

Lest we seem to speak lightly of a very able gentleman, I append a short biography:

Dr. George K. Smith was born in Broome County, N. Y., in 1827 and died in 1895 at the home of his nephew Dr. Frederick W. Smith of Syracuse. A graduate of the University of New York, he received the Mott medal for the best dissection in anatomy, and became an interne at the Brooklyn City Hospital in 1859; demonstrator in anatomy at Long Island College Hospital in 1860; in 1862 Hospital Inspector at Washington, D. C.; and acting assistant surgeon until the end of the war. In 1866 he visited London, Paris, and Edinburgh. While in London he secured the friendly recognition of Sir James Y. Simpson in consequence of a paper "Insertion of the Capsular Ligament of the Hip Joint, etc."

He returned to Brooklyn in 1870, and was appointed adjunct professor of surgery in the Long Island College Hospital and the next year also adjunct professor of anatomy. From 1873 to 1881 he is marked as holding the above titles and also that of lecturer on venereal diseases. He was professionally prominent in Brooklyn from 1860 to about 1890, and the good-natured stories told about his enthusiasm for the procedure of meatotomy reflected only the good will of his contemporaries, one of whom, Dr. George Everson, told me that he had seen him do many perineal incisions and remove middle lobes of the prostate; that he preferred to do median cystotomies for stone, saying that the crushing operations were no good; that once he had seen him diagnose a large kidney by palpation, make a loin incision, tie the pedicle en masse, pack the wound, "all in the patient's home on Columbia Street, and the patient got well." It turned out to be a polycystic kidney.

## BOOK REVIEWS

**DIE ELEKTROCHIRURGIE.** By Prof. Dr. Franz Keysser, Direktor Des Vinzenz-krankenhauses, Berlin. Leipzig, Fischers Medizinische Buchhandlung, 1932.

Electrosurgery within the past ten years has advanced by leaps and bounds into practically every surgical speciality. The world has been looking for a recent, scientific treatise of the subject, particularly one from Europe where electrosurgery had its beginning several decades ago. It was, therefore, timely for Keysser to write his excellent work. Any surgeon, in whatever speciality, would do well to study Keysser before taking up electrosurgery.

After outlining the history of the development of electrosurgery and accurately describing the underlying physical principles and the apparatuses used, he describes the technique in detail and carefully discusses the biophysical effects. He then takes up the diseases treated, one by one, illustrating the results with especially clear pictures. Keysser's results are apparently remarkable and the publishers have reproduced the illustrations in a most commendable way. Not only has he shown the results in the eradication of tumors, but his reconstruction work is of a high type.

**NEOPLASMS OF DOMESTICATED ANIMALS.** Mayo Clinic Monographs. By William H. Feldman, D.V.M., M.D. Foreword by Charles H. Mayo, M.D. 410 pp., 193 illus., Phila., W. B. Saunders Co., 1932.

This book, the latest of the Mayo Clinic Monographs, should be of interest to everyone doing any work on Tumors. It is the most complete study on animal neoplasms known to the reviewer and is written with that care and concise thoroughness which we have come to expect in the books emanating from this Clinic.

**MODERN GENERAL ANESTHESIA, A Practical Handbook.** By James G. Poe, M.D. 231 pp., 12 illus. and 2 charts. Phila., F. A. Davis Co., 1932.

This is an elementary book of 231 pages and attempts to cover the entire subject of general

and local anesthesia. It is possible that this book covers just what the author's students want but, for general usage, it is felt that there are much more complete and practical works available.

**CONQUERING ARTHRITIS.** By H. M. Margolis, M.D. 192 pp. N. Y., Macmillan Co., 1931.

The physician handling the chronic arthritic will do well to recommend the reading of this book which is written for the patient and which, if properly read by the layman, will save the doctor much time spent in unnecessary and usually misunderstood explanations. The author has a faculty of getting his facts across in plain language that should be easily understood by the average patient.

**MANUAL FOR THE JEWISH DIABETIC.** By William S. Collens, B.S., M.D. Foreword by Henry Joachim, M.D. 138 pp. N. Y., Bloch Publ. Co., 1931.

Since diabetes has been called "the Jewish disease" it is interesting to know that this volume is said to be the first manual on diabetic diets which takes into account the Jewish dietary laws. The purpose for which this book was written has been well accomplished.

**ATLAS DE RADIOGRAPHIE OSSEUSE. Vol. 1. (The Normal Skeleton.)** By G. Haret and A. Dariaux, Electroradiologists of the Hospitals of Paris, and Jean Quenu, Assistant Professor to the Faculty of Medicine, Surgeon of the Hospitals of Paris, with the collaboration of H. P. Chatellier, Oto-Rhino-Laryngologist of the Hospitals. Ed. 2, revised and greatly enlarged. Preface by Prof. Pierre Duval. Paris, Masson et Cie, 1932.

The medical profession more and more appreciates the need of atlases of radiological anatomy, the first edition of this beautiful work published in 1927 having been exhausted within a short time. Profiting by the reception given the first edition, the authors have added numerous illustrations, others of medi-

ocre value have been replaced by better ones, and some which seemed superfluous have been entirely omitted. Special attention has been given to the choice of illustrations at various ages to permit the student to follow the development of the points of ossification, and their final complete development. A revised chapter discusses the radiography of the fetus in utero, and an entirely new chapter deals with supernumerary bones, familiarity with which is so necessary for the differential diagnosis of certain fractures.

The bookmanship of the work is much improved over the first edition, the reproduction of the roentgenograms leaving little to be desired. The large size of the pages make it possible to reproduce nearly all the films without reduction in size.

Two other volumes on bones are in preparation, one dealing with fractures and another with diseases of bone.

**HYPERTENSION AND NEPHRITIS.** By Arthur M. Fishberg, M.D. 619 pp. 38 eng. and 1 col. pl. Ed. 2, thoroughly revised and enlarged. Phila., Lea & Febiger, 1931.

The second edition, in a space of only a few years, of a monograph on Hypertension and Nephritis is in itself sufficient proof of the value of this work. In a little over 600 pages, this book covers the ground indicated in its title thoroughly and completely, showing evidence of much original work. The book also contains a splendid survey of all the work that has been done in these lines. The bibliographies are well selected.

**MANUAL OF BACTERIOLOGY.** By Robert Muir, M.D., SC.D., LL.D., F.R.S. and the late James Ritchie, M.D., F.R.C.P. (Ed). Revised by Carl H. Browning, M.D., D.P.H., F.R.S. and Thomas J. Mackie, M.D., D.P.H. Ed. 9. 866 pp., 212 illus. and 6 col. pl. Humphrey Milford, Oxford Univ. Press, 1932.

The ninth edition of this classic is like a visit from a friend of our youth. Thoroughly practical, condensed and yet complete, this little manual is one of the best one volume works on Bacteriology available in the English language.

**SCHMERZVERHÜTUNG ZWÖLF VORLESUNGEN.** By Dr. Fritz Starlinger. Wien, Julius Springer, 1931, 105 pp.

In twelve short lectures comprising in all 105 pages, the entire subject of Anesthesia is given in short but comprehensive reviews. Much philosophical discussion is included and indications and contraindications for the various drugs are pointed out. The author is conversant with the literature and seems to have much practical experience. It is a splendid introduction to larger works on Anesthesia.

**DIE SCHLEIMHAUT DES VERDAUUNGSKANALS IM RÖNTGENBILD: EINE NORMALE UND PATHOLOGISCHE RÖNTGENANATOMIE DER INNENWAND DES VERDAUUNGSKANALS.** By Henri Chaoul and Albert Adam. Berl., Urban & Schwarzenberg, 1931.

This is a splendid book, well written, and beautifully illustrated; the reproductions of roentgenograms are excellent. The technique followed is very much like that of Berg and Forssell. With this method only a little barium is given and every effort is made to show detail in the folds of mucous membrane of the stomach and bowel. Special forms of compression capsules are used. The films obtained are beautiful and often show very clearly lesions which would not appear on ordinary plates made when the stomach is full.

In America many roentgenologists obtained very much the same results by giving the patient only a few swallows of barium and then palpating the stomach carefully while the patient is back of the fluoroscopic screen.

There are excellent chapters on the historical development of the new method of showing the mucosal folds, on the appearance of the folds in the normal esophagus, stomach, and bowel and on the change that takes place in these folds during the progress of peristalsis. In the second part of the book the writers describe changes which take place in the folds in the presence of various diseases and after the performance of various operations. There is an excellent bibliography containing many hundreds of titles. Altogether the book is one that every roentgenologist and clinician would like to have in his library.

# PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

## SIXTH INSTALLMENT

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## CHAPTER XXI

### TREATMENT OF IRREPARABLE NERVE INJURIES

There is a certain group of nerve injuries to which the term "irreparable" may be given. This group includes those cases in which the nerve ends have been sutured but in which recovery of muscle function fails to occur and those nerve injuries which are so extensive that end-to-end suture cannot be obtained. It is a well-known fact that the percentage of functional recovery after nerve suture is much higher following civil than war injuries. In such instances it becomes necessary to resort to various supplementary procedures which may afford some degree of function in the involved extremity.

These alternative surgical methods may be classed in general under three heads: (1) tendon transplantation, (2) neurotization of the paralyzed muscles and (3) immobilization of joints. None of these supplementary operations should be employed until it is established definitely that the possibility of nerve regeneration is precluded.

#### TENDON TRANSPLANTATION

While the principles which govern tendon transplantations in the upper and lower extremities are the same, it must not be forgotten that in the upper extremity mobility is the chief aim to be accomplished and in the lower extremity fixation for stable weight bearing is essential. To obtain mobility it is requisite that the joint upon which the transplanted tendon is to act should not be restricted in its movements. A fixed or deformed joint cannot be expected to respond to its fullest function even though the tendon transplantation is perfect. Before a tendon is selected for transplantation the ability of its muscle belly to perform the task required of it must be determined carefully. One should not expect a normally small weak muscle to perform the action of a stronger muscle though

one may reasonably expect it to hypertrophy to a degree comparable to its added burden. One should also have a definite knowledge of the synergistic action of muscles. It is a physiological law that each contracting muscle group has its antagonistic muscles which relax simultaneously during the movement. On the other hand, muscles which may appear to be anatomically antagonistic may contract simultaneously to fix a joint during all or part of the movement and thus act physiologically in a supplementary manner. The choice of a tendon to be transplanted may also be made less difficult by a knowledge of those muscles which normally supplement or take over the action of a paralyzed muscle, at times to such an extent that the determination of individual muscle paralysis may be difficult to determine. Attention has already been called to these supplementary muscle movements.

Technically there are several important factors which must be kept in mind. First of all, there should be a direct pull from the point of origin to the proposed point of insertion. Angulation, of necessity, will reduce the efficiency of the transplanted tendon. Often long incisions and extensive mobilization of the tendon and muscle belly may be necessary to obtain this end. Further, the transplanted tendon should be placed beneath other muscle bodies or the fatty superficial tissue rather than beneath the skin where adhesions may easily curtail the functional result. Perhaps the most difficult step of all in tendon transplantation is to determine at what tension the tendon should be sutured to give the desired end result. Immediately after severance of the tendon, its muscle fibers contract and its length shortens. One should never stretch the muscle to the point where its inherent tone may be destroyed. The joint to which the tendon is to be sutured should be flexed or extended to the degree to which function in the joint is desired. The tendon should then be attached with the joint in that position. Under such circumstances when the muscle fibers relax, there will be a residual tension comparable to that in the muscle before it was transplanted.



Before transplantation a splint should be prepared to hold the joint in the desired position. This should be applied immediately so that the suture line may be protected during the period required for firm healing. Mason and Shearon have shown that the line of union should be healed sufficiently by the end of two weeks so that passive movements may be instituted without fear of avulsion. The institution and performance of massage and active and passive movements should then be started to avoid restriction of joint movements by immobilization and to stretch any adhesions which may have a tendency to form. These physical therapy procedures should be undertaken and controlled under the same conditions as have been outlined in the chapter devoted to Postoperative Treatment. The splint should be worn the greater part of the time until the patient is able to grasp the re-educational movement and until the tendon is able to bear its new functional demand without fatigue.

The use of tendon transplants may be better explained by specific illustrations for individual irreparable nerve lesions.

**RADIAL NERVE LESIONS:** The wrist and finger drop deformity of an irreparable radial nerve injury lends itself most satisfactorily to repair by tendon transplantation. There have been several operative procedures devised by Sir Robert Jones, Murphy and others to correct the functional disability which accompanies a wrist drop. The essential steps in this procedure are (1) the transplantation of the pronator radii teres into the long and short extensor carpi radialis to produce dorsal flexion of the wrist and (2) the transplantation of the extensor carpi ulnaris tendon into the flexor carpi ulnaris to prevent deviation of the hand to the radial side.

To accomplish these procedures an incision is made along the radial side of the forearm in its middle third. The plane of cleavage between the brachioradialis and the extensors of the wrist is dissected down to the radius. The insertion of the pronator teres is then divided from the radius and with the wrist in extension its tendon is slipped through a slit in

the extensor carpi radialis longior and breviar tendons and anchored. To prevent radial deviation in extension the tendon of the extensor carpi ulnaris is divided and transplanted into

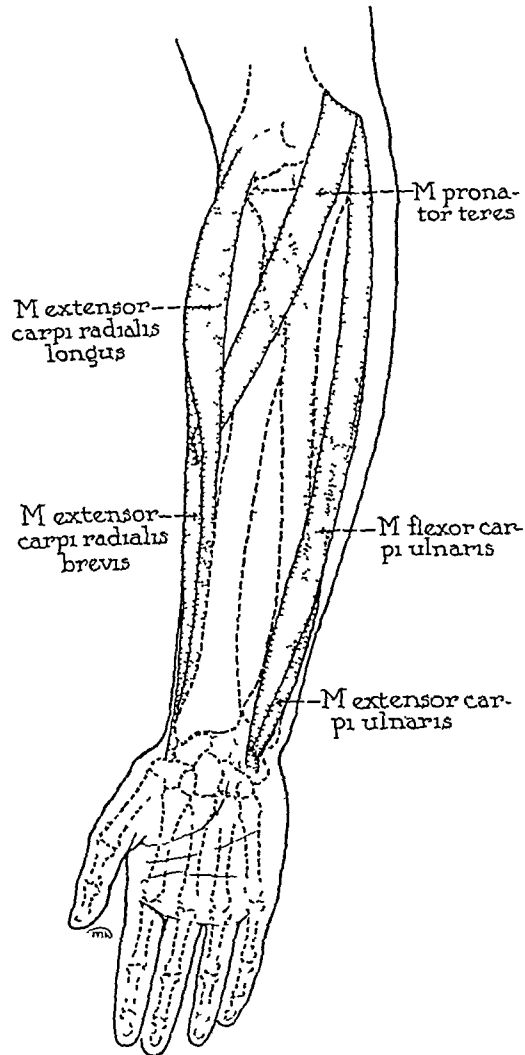


FIG. 134. Transplantation of tendons for repair of wrist drop in radial nerve paralysis.

that of the flexor carpi ulnaris (Fig. 134).

For the restoration of extension of the fingers and thumb it is necessary to transplant the flexor carpi ulnaris tendon into the extensor tendons of the third, fourth and fifth digits and

the flexor carpi radialis into the extensor ossis metacarpi pollicis, extensor pollicis longus and brevis and into the extensor tendons of the index finger. The palmaris longus tendon may be used to transplant into the long extensor tendon of the thumb. To obtain these transplants it is necessary to make a long incision on the ventroradial aspect of the forearm which begins at the insertion of the flexor carpi radialis tendon and extends to the middle of the forearm. This tendon should be well mobilized but care must be taken to protect the radial artery. A similar incision on the ventro-ulnar side of the forearm will be necessary to effect a similar immobilization of the flexor carpi ulnaris tendon. A third incision should be placed on the mid-dorsal surface of the forearm from the wrist joint to the middle of the forearm. The superficial tissues should be undermined carefully so that the ventroradial and ventro-ulnar incisions connect. This procedure will expose all of the extensor tendons which are to be utilized. The divided flexor carpi ulnaris tendon should then be brought to the dorsum of the wrist and its end passed through slits made in the extensor tendons of the middle, ring and little fingers and there anchored with these fingers in extension. Likewise, the end of the flexor carpi radialis tendon is passed through slits made in the long extensor of the thumb and both extensors of the index finger and anchored with the thumb in complete extension and abduction and the index finger in full extension. After the wounds are carefully closed a splint should be applied to keep the wrist, thumb and fingers in extension (Fig. 135).

Stoffel has devised a fascial transplant operation to correct the pendulous hand and fingers in this group of cases. A fascial strip is attached to the radius and ulna and to the first and second metacarpal bones on the radial side of the extensor tendons and to the fifth metacarpal bone on the ulnar side of the extensor tendons. The wrist is held in marked dorsiflexion during this attachment. If it is desired to raise the fingers also the distal end of the fascia is cut into five points which are sutured to the proximal phalanges. It should be pointed

out that in certain cases so operated upon the fascia has stretched and the deformity has recurred.

**MEDIAN NERVE LESIONS:** The loss of sensation in the

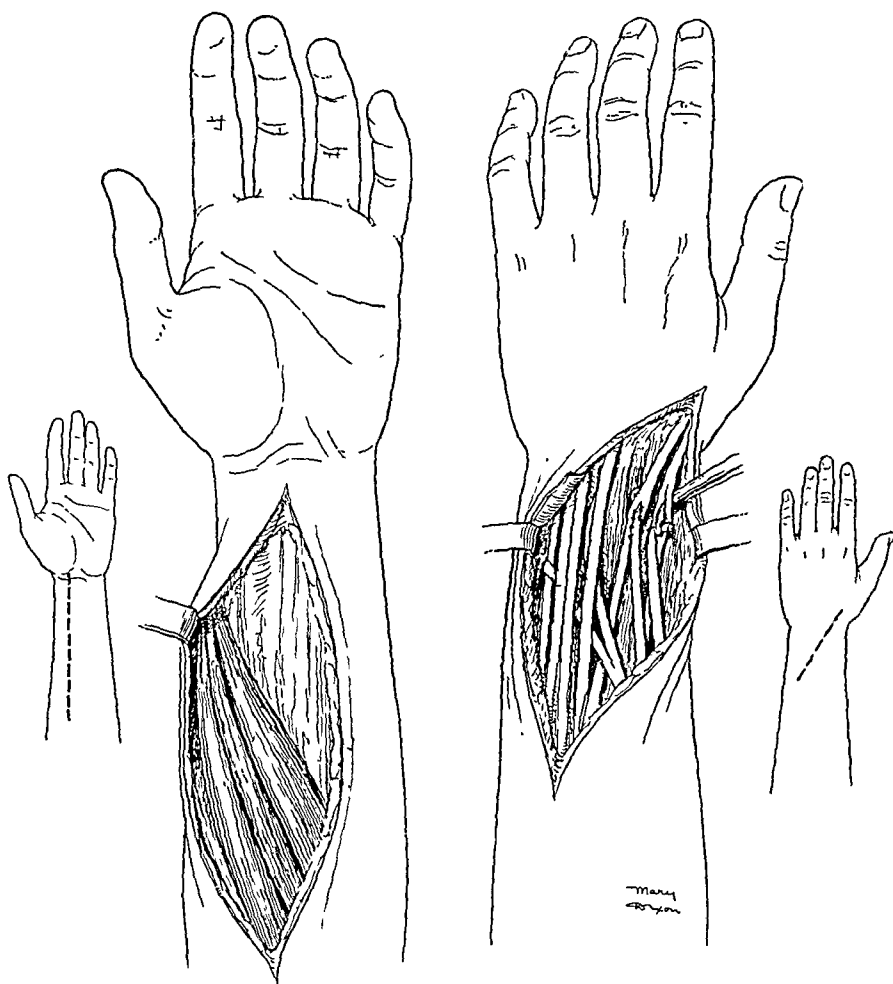


FIG. 135. Transplantation of tendons to paralyzed extensors of fingers and thumb in radial nerve paralysis.

index and middle fingers which results from a median nerve lesion makes the attempts to compensate for an irreparable lesion doubly difficult. Though the results are not particularly encouraging one may have recourse to an autogenous nerve graft. Or, one may attempt to unite the central end of the superficial sensory branch of the radial nerve to the distal end

of the median. It must be remembered that even though regeneration may occur under such circumstances, tactile sensation which is most important may still be lacking. In the presence of a combined median and ulnar lesion it may be possible to anastomose the central end of the ulnar and the distal end of the median. While this sacrifices the ulnar distribution the success of this procedure may afford more ultimate function than would otherwise be possible. These facts only emphasize how important it is to use every method at one's command to obtain a satisfactory end-to-end median nerve suture.

Since the ulnar half of the flexor digitorum profundus provides flexion in the fourth, fifth and occasionally the middle finger it is necessary only to provide flexion to the index finger and flexion and opposition to the thumb. To accomplish these results the flexor tendons may be anastomosed to the flexor carpi ulnaris. Ney, however, has obtained more satisfactory results by anastomosis of the tendon of the extensor ossis metacarpi pollicis to the flexor pollicis longus and then transplanting the extensor carpi radialis into the flexor tendons of the index finger. If the thumb has become displaced laterally so that its position of function cannot be maintained it may be necessary to perform an arthrodesis and fix it into a position of opposition and abduction. Without the thumb in this position the greatest functional restoration of the hand cannot be obtained. Ney has devised an operation for restoration of the opponens function of the thumb which he states duplicates this action and at the same time allows complete extension. The procedure consists in bringing the short extensor tendon of the thumb through a tunnel under the fat of the superficial fascia. It is then passed beneath the annular ligament to the wrist where it is anastomosed to the palmaris longus tendon.

**ULNAR NERVE LESIONS:** The failure of return of function in the intrinsic muscles of the hand supplied by the ulnar nerve produces a particularly disabling deformity. A marked degree of atrophy occurs in these highly specialized intrinsic muscles

in a comparatively short time. Paralysis of the flexor carpi ulnaris and the ulnar half of the flexor digitorum profundus muscle may be compensated for by tendon anastomosis to the unparalyzed portion of the latter muscle which is supplied by the median nerve. Restoration of the function lost by paralysis of the small hand muscles will be discussed in the following paragraphs which deal with irreparable combined lesions of the median and ulnar nerves.

**MEDIAN AND ULNAR NERVE LESIONS:** Irreparable lesions of the median and ulnar nerves combined result in a deformity which renders the hand useless unless some degree of flexion of the fingers can be obtained by tendon transplantation. Occasionally following a suture of these nerves there may be a restoration of function in the flexors of the wrist and fingers, and in the pronators, but there is a residual disability due to atrophy of the small hand muscles. Under such circumstances the loss of the opponens function of the thumb, inability to flex the metacarpophalangeal joints and loss of extension of the interphalangeal joints and hyperextension of the metacarpophalangeal joints reduces the function of the hand considerably.

To restore the opponens action to the thumb the palmaris longus tendon may be sutured to the short extensor tendon of the thumb. If the palmaris longus tendon is absent the flexor carpi radialis may be utilized. An incision is made in the midline over the course of the palmaris longus tendon from the base of the palm below the annular ligament upward for about 3 inches. The palmaris longus tendon is divided and mobilized. The annular ligament is divided longitudinally for about an inch and a circular opening is made through it near its distal border. Another incision is made over the dorsal surface of the thumb from a point just distal to the metacarpophalangeal joint to the radiocarpal articulation. This incision should bisect the anatomical snuff box. The sheath of the short extensor tendon of the thumb is opened and the tendon is isolated. It is then divided opposite the proximal end of the incision. The free end of the tendon, which is still attached to the

base of the proximal phalanx of the thumb is then passed beneath the superficial tissues to the circular opening in the annular ligament. It is passed through this and sutured to

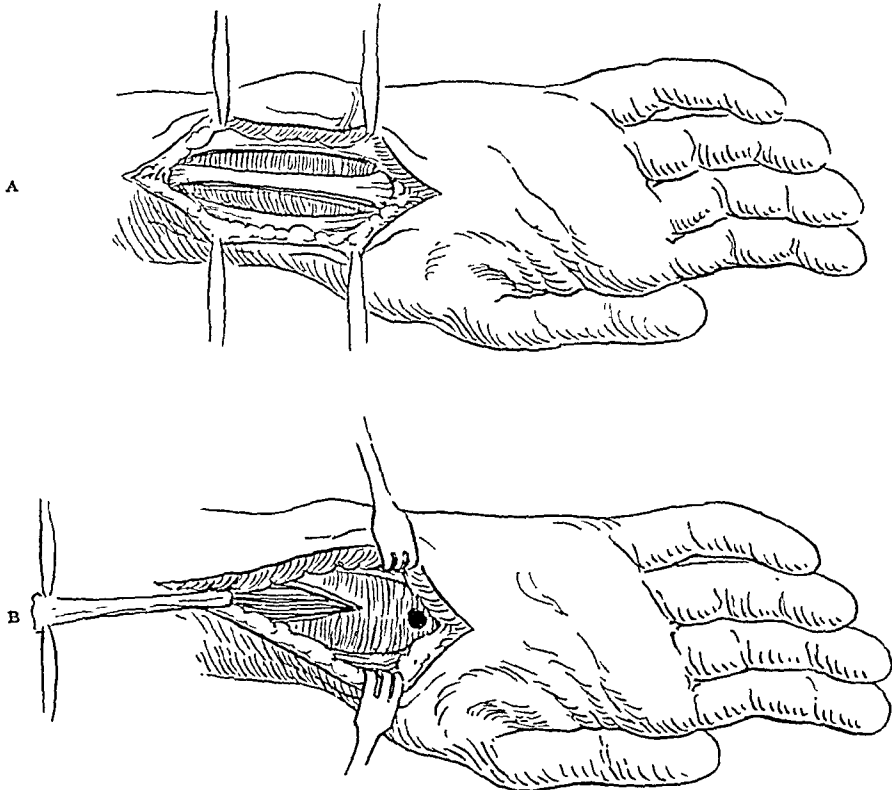


FIG. 136. Tendon transplantation to restore opposing action of thumb in median-ulnar nerve paralysis. (After Ney.)

- A. Exposure of palmaris longus tendon.
- B. Division of palmaris longus. Opening in palmar fascia at upper end of annular ligament.

the palmaris longus. The thumb should lie across the palm in an opposed and abducted position following this operation. Inasmuch as contraction of the palmaris longus tendon always accompanies prehension of the thumb the action afforded by this transplant is synergistic (Fig. 136).

Stiles has devised an operation to restore flexion of the metacarpophalangeal and extension of the interphalangeal joints. The operation consists in suturing the insertions of the

flexor digitorum sublimis tendons to the extensor digitorum communis at a point distal to the metacarpophalangeal joints. Through a mid-dorsal incision the common extensor tendons

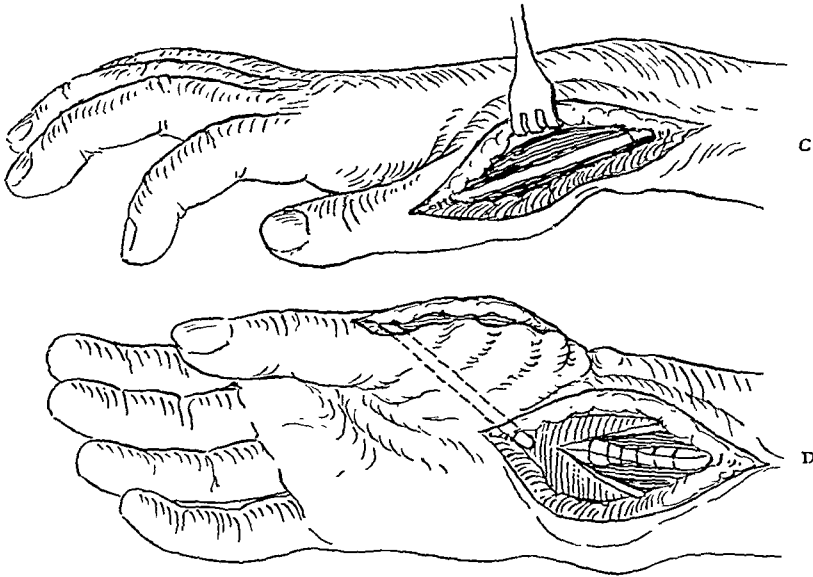


FIG. 136.

c. Exposure of short extensor of thumb.

d. Passage of divided short extensor tendon through a subcutaneous tunnel in thenar eminence and through opening in palmar fascia. It is then anastomosed to palmar longus tendon. This holds thumb in opposens position.

are exposed and the insertions of the interossei and lumbricales muscles into its lateral aspect are freed. By separate incisions along the flexor surface of each finger the flexor tendons are exposed from the palmar crease to the distal interphalangeal joint. The tendon sheath is opened by a small lateral incision opposite the middle interphalangeal joint where the sublimis tendons divide to allow the deep tendon to pass distally. The insertions of the sublimis tendons are divided. Another incision is made through the flexor tendon sheath opposite the metacarpophalangeal joint and the ends of the sublimis tendons are pulled out of the sheath. The tendon sheath incisions must be made laterally and not directly beneath the skin incision. Further, the small attachments of the profundus tendons



opposite each phalanx must not be disturbed. Each half of the sublimis tendon should be passed around the digit to the dorsal incision and then should be sutured through the extensor tendon at the point where it receives the lumbricales and interossei muscle insertions. The tendons should be sutured with the metacarpophalangeal joints in flexion and the interphalangeal joints in extension. After closure of the incisions the fingers should be fixed in that position.

In the event that the lesions of the median and ulnar nerves are high so that the flexor tendons to the wrist and fingers are also paralyzed, an attempt may be made to supply some degree of flexion to the fingers by transplantation of the extensor tendons. By a long incision from the base of the thumb over the dorsal aspect of the forearm to its upper third the extensor radialis longior tendon is freed and divided at its insertion into the second metacarpal bone. The tendon is divided into two slips, one of which is sutured into the flexor tendons of the index finger and the other into the tendons of the middle finger. In a like manner the tendon of the brachioradialis is sutured to the flexor tendons of the ring and fifth fingers. The tendon of the extensor ossis metacarpi pollicis is divided at its insertion and sutured to the long flexor tendon of the thumb. The incisions are closed and the fingers are held in flexion, the position in which the transplants are sutured.

**SCIATIC NERVE LESIONS:** The major disabling defect which follows sciatic nerve lesions is the loss of stability of the foot. The loss of motor function which follows a lesion of the tibial portion of the sciatic is more disabling than that which accompanies a lesion of the peroneal nerve. If the dorsal flexion of the foot is permanently lost, arthrodesis of the ankle joint or the operation of tendon slinging may be used to correct the drop foot. Of these two procedures the latter is more satisfactory because arthrodesis cannot stabilize the anterior half of the foot. No muscle or tendon groups are available to supplement the movements of the anterolateral group of muscles which are supplied by the peroneal nerve.

Tendon slinging consists in passing the upper parts of the tendons of the tibialis anticus and peroneus longus through a hole in the shaft of the tibia where they are sutured. The

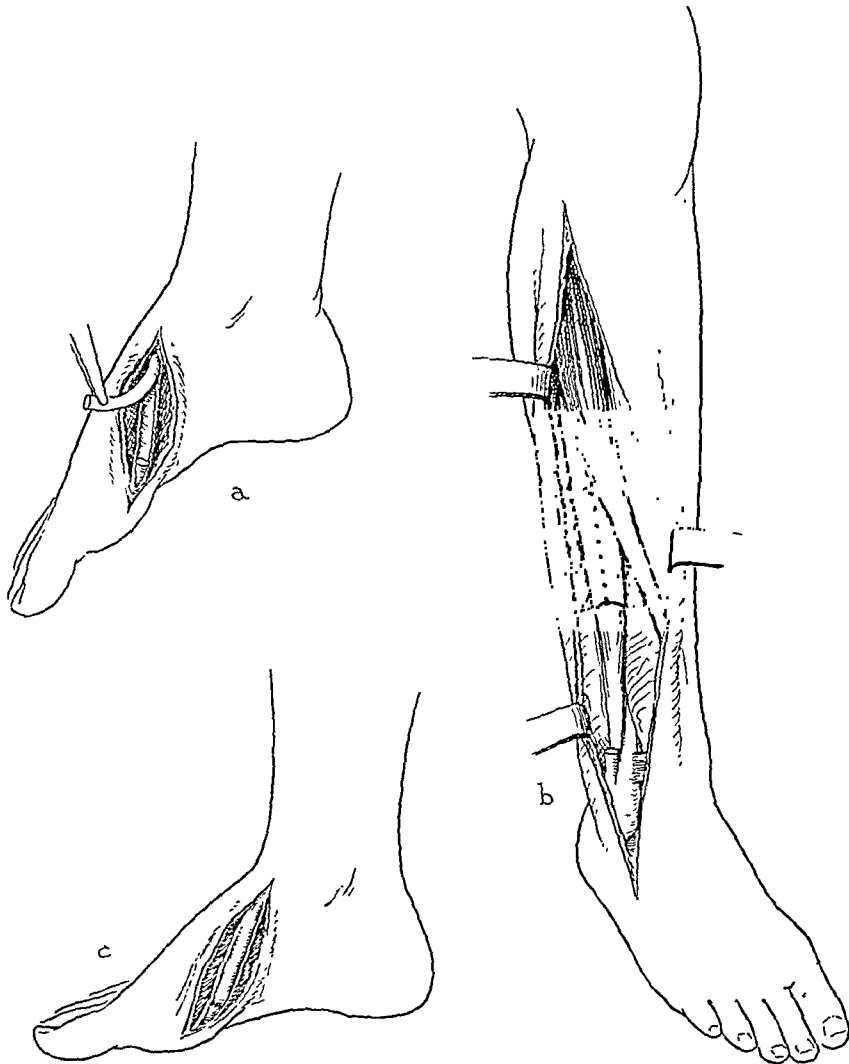


FIG. 137. Tendon slinging to overcome foot drop in peroneal nerve paralysis.

peroneus brevis may also be used in this procedure. The extensor tendons of the toes are used in a like manner to suspend the anterior half of the foot (Fig. 137).

## NEUROTIZATION OF MUSCLES

It has been shown by experimental and clinical work that a muscle may be innervated directly by the implantation of a nerve into the muscle and that motor end plates will develop on the muscle fibers. This procedure may be found useful if a nerve branch to a given muscle has been severed near its entrance into the muscle and it can be freed and implanted at a higher level.

In 1908, Hacker implanted the central end of the spinal accessory nerve and a motor branch from the cervical plexus into the trapezius muscle. Later he obtained a contraction of the trapezius by stimulation of the nerves. In 1917, Kölliker obtained a response after implantation of the entire median nerve into the paralyzed biceps muscle in two cases. Forrester performed direct implantation of the median, peroneal and musculocutaneous nerves in six cases with complete return of function in four of them, partial return in one and failure in the remaining case. Erlacher, in 1914, implanted the median nerve into the biceps muscle of monkeys after first sectioning the musculocutaneous nerve. He obtained not only contraction of the muscle upon stimulation but was able to demonstrate histologically normal neuromuscular connections. In the same year Heineke implanted the peroneal nerve of the rabbit into the gastrocnemius muscle after severance of the tibial. He obtained regeneration within twenty-eight days. Steindler, in 1916, attempted to corroborate the experimental results of Erlacher and Heineke. He sectioned the femoral in dogs and implanted the tibial into the vastus externus muscle. After ten weeks Steindler was able to produce contractions in the muscle by stimulation of the implanted nerve with a current which was weak enough to avoid retrograde stimulation of the flexor muscles. It was observed grossly that the muscle fibers directly about the implanted nerve were redder in color than those at a distance. In spite of precautions taken to avoid its occurrence Steindler found in some instances that a few fine

regenerated branches from the severed femoral nerve entered the muscle. These were in the minority so that they played but a small part in the neurotization of the muscle. In none of his experiments was Steindler able to show that the muscle fibers became hyper-neurotized.

In 1916, Hoessly implanted the branch of the spinal accessory which supplies the sternomastoid muscle into the laryngeal muscles of dogs after first sectioning the recurrent laryngeal nerve. His experimental results were so successful that he proposed the operation for human cases. Elsberg, in 1917, found that if two nerves were implanted into a paralyzed muscle of a rabbit and if one of the nerves was the severed nerve which normally supplied the muscle, this nerve alone would regenerate and establish motor end plates.

The successful clinical application of neurotization may depend upon the length of time paralysis has existed before a nerve is implanted. In other words, the anatomical change in the muscle fibers may be such as to obviate any possibility of regeneration. However, Steindler calls attention to the fact that in many instances a large amount of apparently healthy muscle fibers are found in muscles which have been paralyzed for several years.

The technical procedure of nerve implantation is not difficult. The central end of the nerve should be freed and sectioned across until normal appearing funiculi are visible. Two fine silk sutures are passed through the epineurium about 2 mm. from its end. In selecting the point on the muscle into which the implantation is to be made the action of the muscle and its movements in changes of the position of the extremity must be kept in mind so that undue tension on the nerve will not be exerted. A small opening is made in the muscle parallel to its fibers. Complete hemostasis of the nerve end and of the muscle should be obtained. The nerve should be sutured into the muscle with the epineural sutures already placed so that the nerve end is directed toward the muscle's point of insertion. The muscle incision should be closed over the implanted nerve.

If necessary other epineural sutures may be used to avoid angulation of the nerve (Fig. 138).

An alternative method for the neurotization of paralyzed

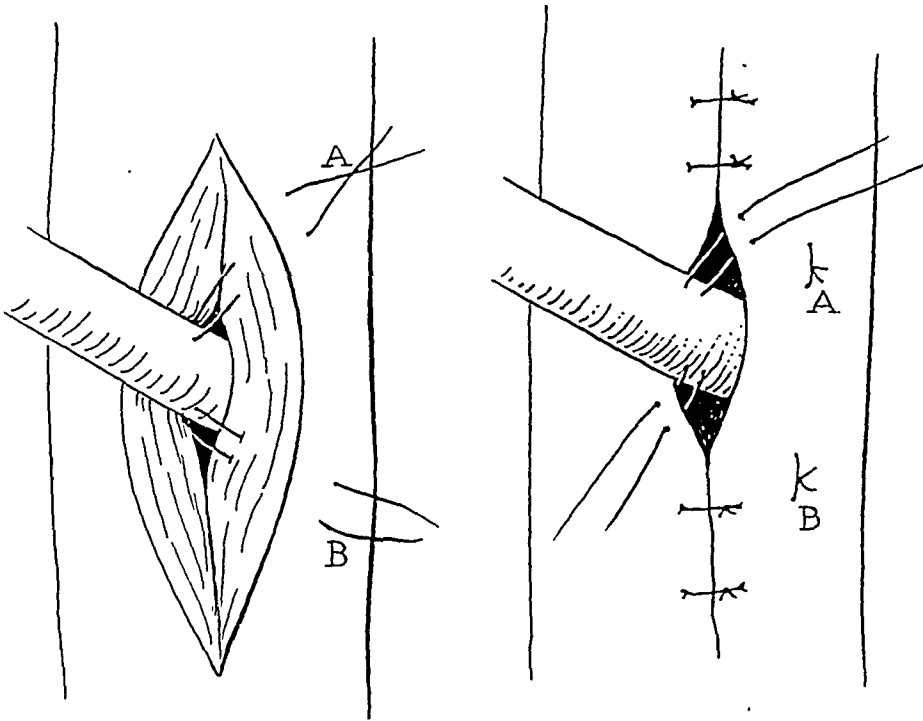


FIG. 138. Technique of neurotization of muscles.

muscles was first suggested by Gersuny, in 1906. His method consists in the transplantation of a muscle flap with its nerve supply intact into the paralyzed muscle. The normal nerve fibers should then grow out from the transplanted muscle flap. Gersuny transplanted a flap from the trapezius into the paralyzed deltoid and stated that he obtained a good functional result. Erlacher also reported successful experimental and clinical results by this method and emphasized the importance of using a broad base for the flap so as to maintain its nerve supply. Nutt, in 1917, reported 20 cases of muscle flap transplantations in patients with infantile paralysis. Thirteen of these were failures; 2 showed good and 4 fair recovery. It is the

consensus of opinion that neurotization by the implantation of the nerve itself is superior to that of muscle implantation.

#### IMMOBILIZATION OF JOINTS

In old neglected cases of nerve injuries which may prove finally to be irreparable, the only procedure which may afford even slight functional improvement is immobilization of the joint in the position of greatest function. In the lower extremity both the knee and ankle joints may be immobilized with some degree of functional improvement. In the upper extremity the wrist and elbow less frequently call for this operation.

Surgical fixation of the ankle joint to afford a firm weight bearing surface in patients with a foot drop has been described previously in the discussion of irreparable lesions of the tibial nerve. It should be emphasized again that arthrodesis of the ankle joint does not stabilize the anterior half of the foot.

In irreparable defects of the radial nerve which have not been treated with massage and physical therapy so that tendon transplantations are valueless it may be a distinct advantage to fix the wrist joint in extension. This position approximates the position of function of the hand and one needs only to attempt to flex the fingers with the wrist in flexion to realize how much function this adds to the hand. In a like manner the elbow joint may be ankylosed in semiflexion with the forearm midway between pronation and supination to add materially to the functional improvement of the upper extremity.

## CHAPTER XXII

### THE RADIAL NERVE

Of all the peripheral nerves the radial is the most commonly injured in civil life. During the war radial nerve injuries constituted almost one-fourth of all the nerve injuries. In civil life it is commonly involved because of its length and winding course about the humerus. It is exposed to wounds and to other injury from external sources. Dislocation of the shoulder and fractures of the humerus may produce an immediate injury to the nerve. Callus formation about a fracture, traumatic aneurysms and compression by a bandage, cast or splint may subsequently produce an involvement of the nerve. It may become involved in a bony newgrowth or it may be affected by tuberculosis or syphilis of the bone. It may be disregarded by the surgeon and injured during operations upon the upper extremity. It is common to have a radial nerve paralysis follow continued pressure upon the arm, such as occurs particularly in a drunken sleep. This type of lesion has been called "Saturday night palsy" or "sleep paralysis." Rarely it has been observed in long, wasting illnesses due to pressure of the arm against the bed. Radial nerve lesions have occurred as the result of malposition during a prolonged anesthesia and occasionally it has been observed as the result of carrying very heavy objects, or severe sudden stretching of the extremity. The local reaction which follows therapeutic injections of ether, arsphenamine or serum has resulted in partial paralysis of the nerve. Just as there are certain individual characteristics in the recovery of each nerve from a lesion, so may we class the vulnerability of radial nerve to injury since relatively minor injuries always produce a complete motor paralysis.

#### MOTOR SYMPTOMS

The radial is the nerve of extension of the upper extremity. When it is paralyzed, extension of the thumb, proximal

phalanges of the fingers, wrist and elbow and abduction of the thumb on the plane of the palm are impossible. The wrist and fingers are flexed in a position which is termed "wrist drop,"

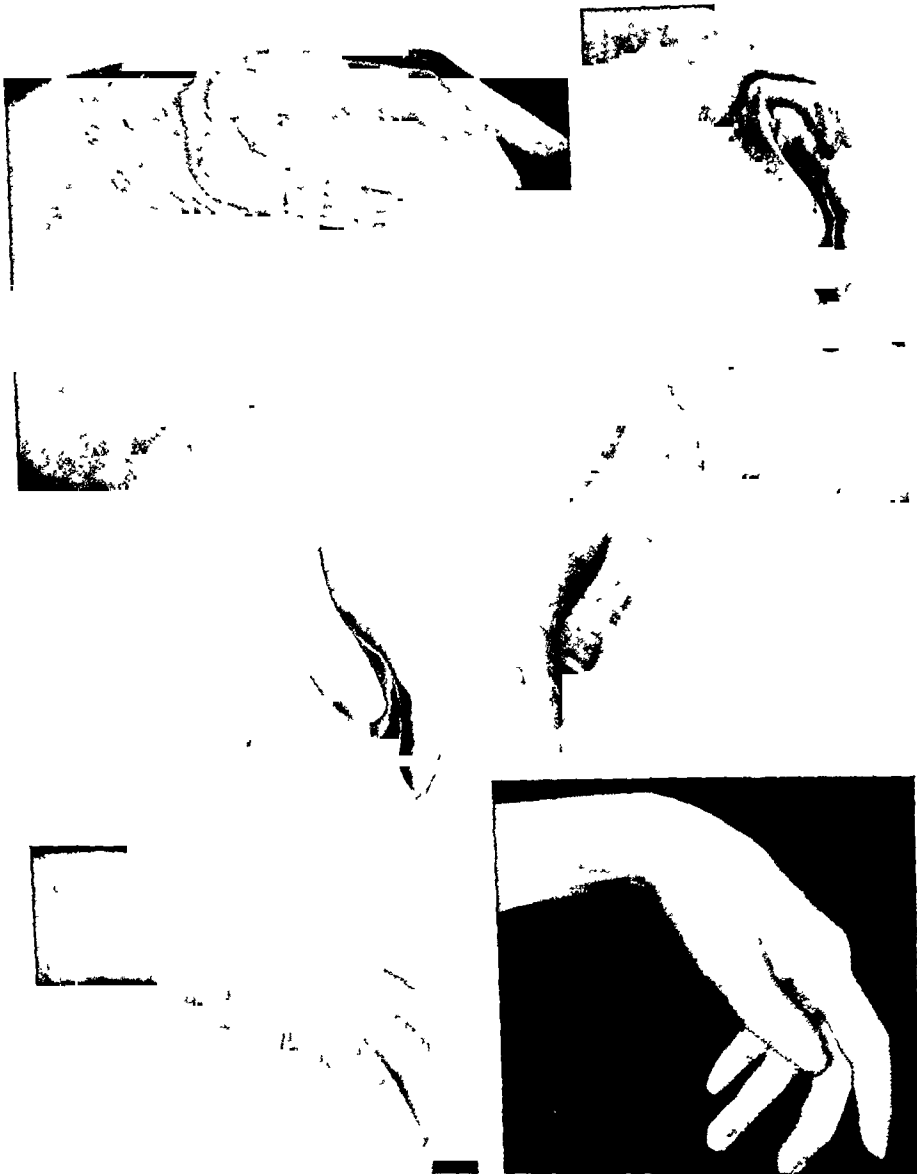


FIG. 139. Wrist drop deformity characteristic of radial nerve paralysis.

and the thumb is adducted and held in the line of the outer border of the index finger (Fig. 139).



In radial nerve paralysis, some muscles not supplied by it function feebly and awkwardly. The flexors of the wrist and fingers are especially affected. The patient cannot adequately

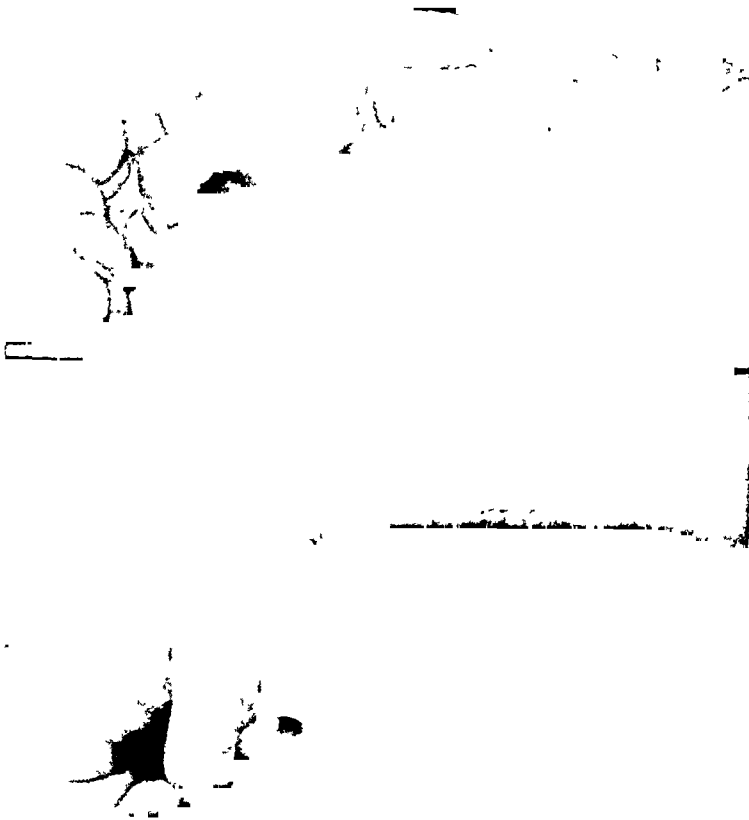


FIG. 140. Inability to close fingers completely in radial nerve paralysis.

make a fist or grasp objects in his hand because complete flexion of the fingers is impossible, due to the impossibility of shortening the distance between the origin and insertion of the extensors of the wrist and fingers by extension at the wrist. (Fig. 140.) The thumb frequently interferes with flexion of the index finger, and the patient must move it aside with the unaffected hand. Unless the hand is placed flatly upon the table,

abduction and adduction of the fingers is difficult. Due to distention of the ligaments of the wrist and thickening of the synovial membranes, the metacarpal bones protrude, forming the well-known "tumor of the wrist."

The best method of testing the function of the triceps muscle is to allow the patient's arm to hang over the back of a chair with the upper portion horizontal and the forearm hanging loosely at right angles to it. The patient is then asked to straighten his arm. The muscle may then be inspected and palpated during the attempt to extend the forearm. Care must be exercised not to misinterpret that extension of the forearm which occurs from a flexed position as the result of gravity controlled by the flexors as true extension. For this reason it is important to have the patient raise his elbow high enough so that it becomes impossible for him to extend the bended forearm by reason of the weight alone. Another way to test the paralysis of the triceps is to extend the elbow, then to ask the patient to resist any attempt to flex the forearm on the arm. Because the long head of the triceps receives its motor supply immediately after the nerve emerges from beneath the tendon of the teres major, complete loss of extension of the forearm is infrequent in radial paralysis.

The brachioradialis muscle is brought into action when flexion of the elbow is attempted with the forearm semipronated. With the extremity in this position the patient is asked to resist extension at the elbow. Under this condition an unparalyzed brachioradialis will stand out prominently. Contrary to generally accepted statements that the biceps cannot aid in supination unless the elbow is partly flexed, attention must be called to the fact that at times the biceps supinates the forearm even when it is completely extended.

Weakness of the extensors of the wrist is observed when the patient attempts to raise the hand against the action of gravity. Care should be taken to keep the elbow and forearm of the patient motionless and resting on a table, with the hand loosely suspended and pronated. When the extensors of the wrist

are paralyzed no contraction is felt during the attempt at extension, while, on the contrary, there is energetic contraction of the flexors of the hands and fingers. Inversely, attempt at



FIG. 141. Lesion of radial nerve which paralyzed extensors of fingers but not those of wrist.

flexion of the fingers does not produce a synergistic extension at the wrist, and it will be found that the patient can neither close his fist nor flex all the phalanges completely. The third phalanges will flex weakly or not at all. To verify lateral movements at the wrist, the possibility of error arising from movement of the elbow should be eliminated by resting the forearm on a table, but the hand should be raised almost to the horizontal instead of being allowed to drop. A certain amount of abduction is possible in paralysis of the extensors through the action of the flexor carpi ulnaris. This abduction, however, is incomplete and faulty, and is accompanied by ventral ulnar deviation.

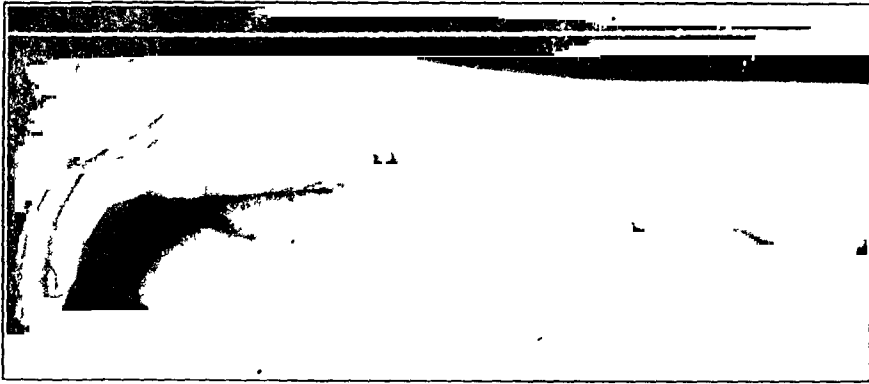
In a lesion of the radial nerve below the elbow, paralysis of the extensors of the fingers may occur without involvement of the extensors of the wrist (Fig. 141). Under these conditions the patient cannot extend the wrist if, at the same time, he attempts to extend the fingers. However, if he flexes the fingers extension of the wrist may then be accomplished. To explain this we must recall the laws governing the action of the

muscles which pass over several joints. Beevor has stated that "when a muscle by passing over two or more joints has two or more different actions, then if only one of these actions be required, other muscles are brought into the movement whose actions are antagonistic to those of the muscles not required." These synergic muscles place the prime movers (in this instance, the extensors of the wrist) in the greatest elongation so as to augment their dynamic power and fix the joint so that the movement may be performed from a secure basis. Still another factor must be considered. Beevor has found that "if the movement of extending the wrist be performed with the fingers actively and fully extended, the extensors of the fingers have to do all the work themselves and against the contraction of the flexors carpi until the amount of work amounts to four or five pounds before the extensors carpi will join in and help them." In the cited instance of paralysis of the extensors of the fingers with preservation of the extensors of the wrist, the extensors of the fingers cannot possibly reach the amount of pull which is necessary before the extensors of the wrist can be made to contract.

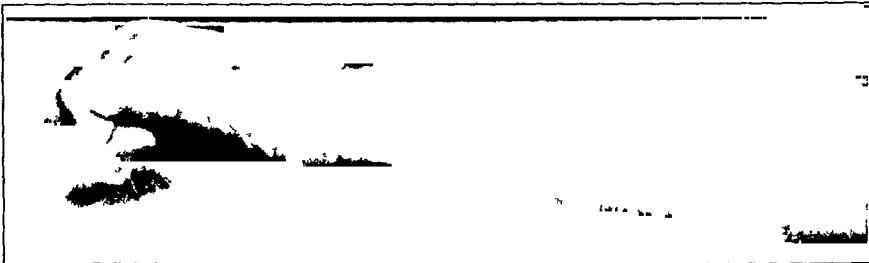
**SUPPLEMENTARY MOVEMENTS:** In a lesion of the radial nerve with paralysis of the extensors of the wrist, dorsal flexion of the hand may be produced by the action of muscles not innervated by the radial nerve. This may occur as the result of energetic contraction of the flexors of the fingers (Fig. 142). This occurs under certain conditions and is noted frequently. When the wrist drop does not exceed an angle of 120 degrees complete flexion of the fingers produces extension at the wrist. In this condition the extensors of the wrist are shortened by contracture and fibrosis so that the angle between the hand and forearm is such that passive dorsi-flexion or dorsal dislocation of the hand occurs. Without this provision the fingers could not be completely closed because of the shortened extensor tendons. The mechanism may be illustrated by using the wrist as a hinge, the hand as the weight and the flexors as the power transmitted through a pulley at the metacarpophal-

langeal joint to a fixed point at the origin of the extensors of the wrist.

In some cases strong contraction of the pronator radii teres



A



B

FIG. 142. Extension of wrist in radial nerve paralysis by supplementary action of flexors of fingers.

will produce extension of the hand on the forearm (Fig. 143). During this movement the head of the radius is strongly depressed toward the palm, the styloid process of the ulna is pulled dorsally and the hand is deviated to the ulnar side. It can be demonstrated readily that the hand can be flexed to a greater degree when the forearm is supinated than when it is pronated. If flexed to its fullest degree when the forearm is supinated, the hand will be seen to extend when strong pronation is instituted. The extension at the wrist is probably due to

two factors: first, increase of the distance between the origin and insertion of the extensors and, second, to a leverage exerted on the scaphoid by the head of the radius. At times, in



FIG. 143. Extension of wrist by supplementary action of pronator radii teres muscle in radial nerve paralysis.

addition to the contraction of the pronator, there is seen strong adduction and apposition of the thumb against the proximal phalanx of the index finger. At the same time resistance to this action is made by the contraction of the lumbrical muscles and the hand is extended on the forearm to a notable degree. During this action the middle, ring and little fingers show flexion at the proximal phalanges and extension of the two distal phalanges. Contrary to the opinion of Duchenne and Bénisty, when examined the American material showed, in agreement with Beevor and Mackenzie, that for pure lateral movements of the wrist the extensors and flexors are both necessary. Adduction and abduction of the wrist are superseded by pronation and supination of the forearm in the position of wrist drop of a radial palsy. If, however, the hand be extended passively to the same plane as that of the forearm, adduction accompanied by flexion of the wrist ensues as the result of contraction of the flexor carpi ulnaris, and occasionally abduction has likewise been observed.

The extensors of the fingers extend the first phalanges of the fingers on the metacarpal bones, and only the first phalanges. To demonstrate the immobility of the first phal-

anges it is necessary to have the wrist passively semi-extended (Fig. 144). Under this condition no extension will take place at the first phalanges. It is possible to tense the proximal



FIG. 144. Hand must be in this position to test accurately extension of proximal phalanges.

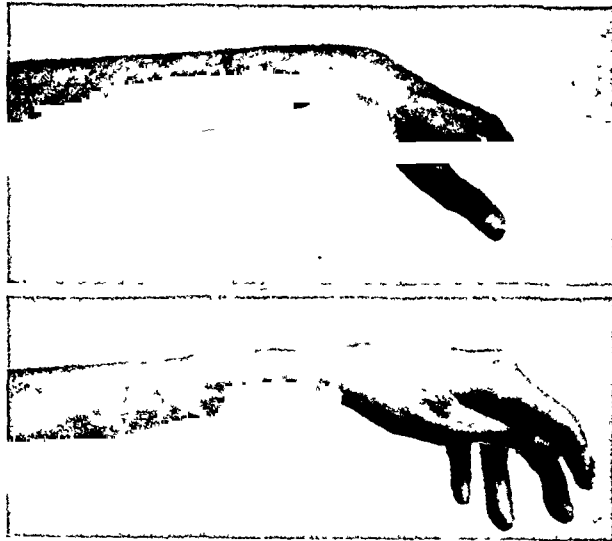


FIG. 145. Extension of wrist in radial nerve paralysis by action of pronator and extension of proximal phalanx of index finger by pressure from thumb.

phalanges of the fingers by extending the terminal ones through the interossei. At the same time, flexion of the proximal phalanges occurs as the result of the unopposed action of the lumbricales. Slight passive extension of the proximal

phalanges may be produced by flexion of the hand at the wrist. Simulation of extension of the first phalanx of the index finger is frequently accomplished by strong adduction



FIG. 146. Attempt to extend distal phalanx of thumb against resistance by use of supplementary muscles.

and opposition of the thumb against the first phalanx of the index finger, which is thereby passively lifted dorsally (Fig. 145).

The extensor longus pollicis extends the two phalanges of the thumb. In addition to it, however, the abductor and adductor pollicis and flexor brevis pollicis are prime movers for extension of the distal phalanx of the thumb. Therefore, although never as complete or as strong as when the extensor longus pollicis is spared, the other muscles may produce extension of the distal phalanx of the thumb (Fig. 146). Simulation of this movement may be produced by flexion of the distal phalanx of the thumb followed by relaxation. Such a mechanism is frequently observed in slight flexion of the fingers in ulnar-median nerve lesions, and flexion and extension of the toes in tibial-peroneal nerve lesions respectively. Abduction of the thumb in the plane of the palm is



impossible in radial nerve paralysis and during attempts to abduct the thumb the tendons of the anatomical snuff box do not stand out in the slightest degree.

### SENSORY SYMPTOMS

Subjective sensory disturbances are rare in radial nerve lesions. Pain is present commonly as the result of injury to other tissues. Pricking, numbness and occasionally pain may be complained of on the dorsum of the forearm or thumb. Rarely a case of burning pain or causalgia has been reported, and in such instances it is possible that the median nerve as well has been injured.

Objective sensory loss is often overlooked because of the widespread overlap to painful sensibility and failure to shave the parts examined. Hamilton, in a careful study, showed that although a lesion of the radial nerve at any point produces less sensory disturbance than one would expect considering its anatomic distribution, it is rarely if ever that some definite area of sensory loss may not be found if it is carefully sought.

In lesions of the nerve in the middle third of the arm, which is the most common level of injury, the internal cutaneous branch is rarely involved. In Hamilton's fifty-five cases in only one instance was the radial nerve injured sufficiently high to produce a loss of sensation in all three of its branches. In twenty-seven instances there was a definite area of sensory involvement in the forearm as well as the hand. In common with our material, the sensation was lost most frequently over the superficial radial nerve distribution. We have never found a case of complete section of the radial at or above the elbow in which sensation was not lost over the distribution of this latter nerve. The area of loss of pain to pin prick is variable and may be completely absent because of the overlap of adjacent uninjured nerves. The loss of sensation to cold and heat of moderate degrees follows the loss of tactile sense, but the preservation of sensation to higher degrees of temperature

is coextensive with the loss to pain. Sense of position is not notably impaired, but vibration sense is defective over the thumb.

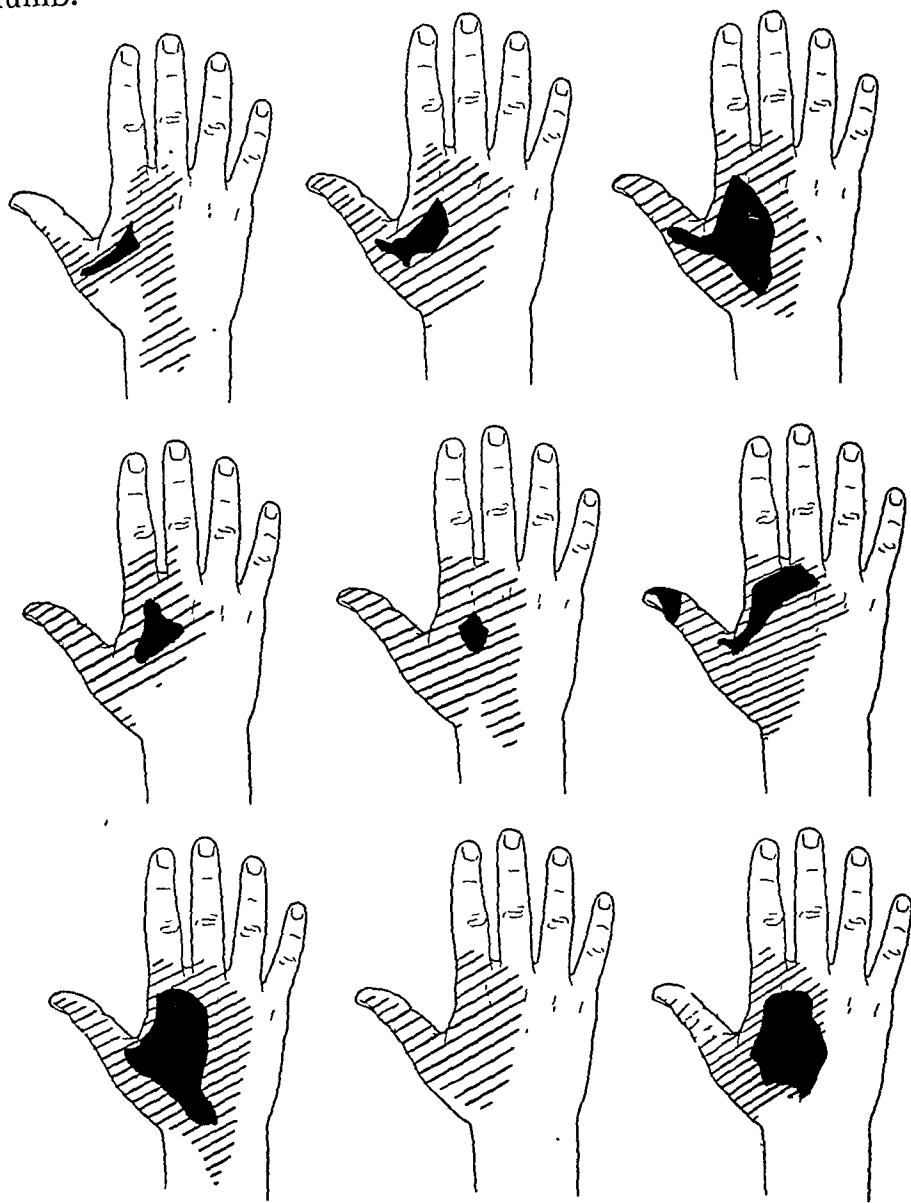


FIG. 147. Variability of loss of pain in a radial nerve lesion soon after injury.

The cases of radial nerve lesions, certified at operation or examined less than thirty-seven days after resection and

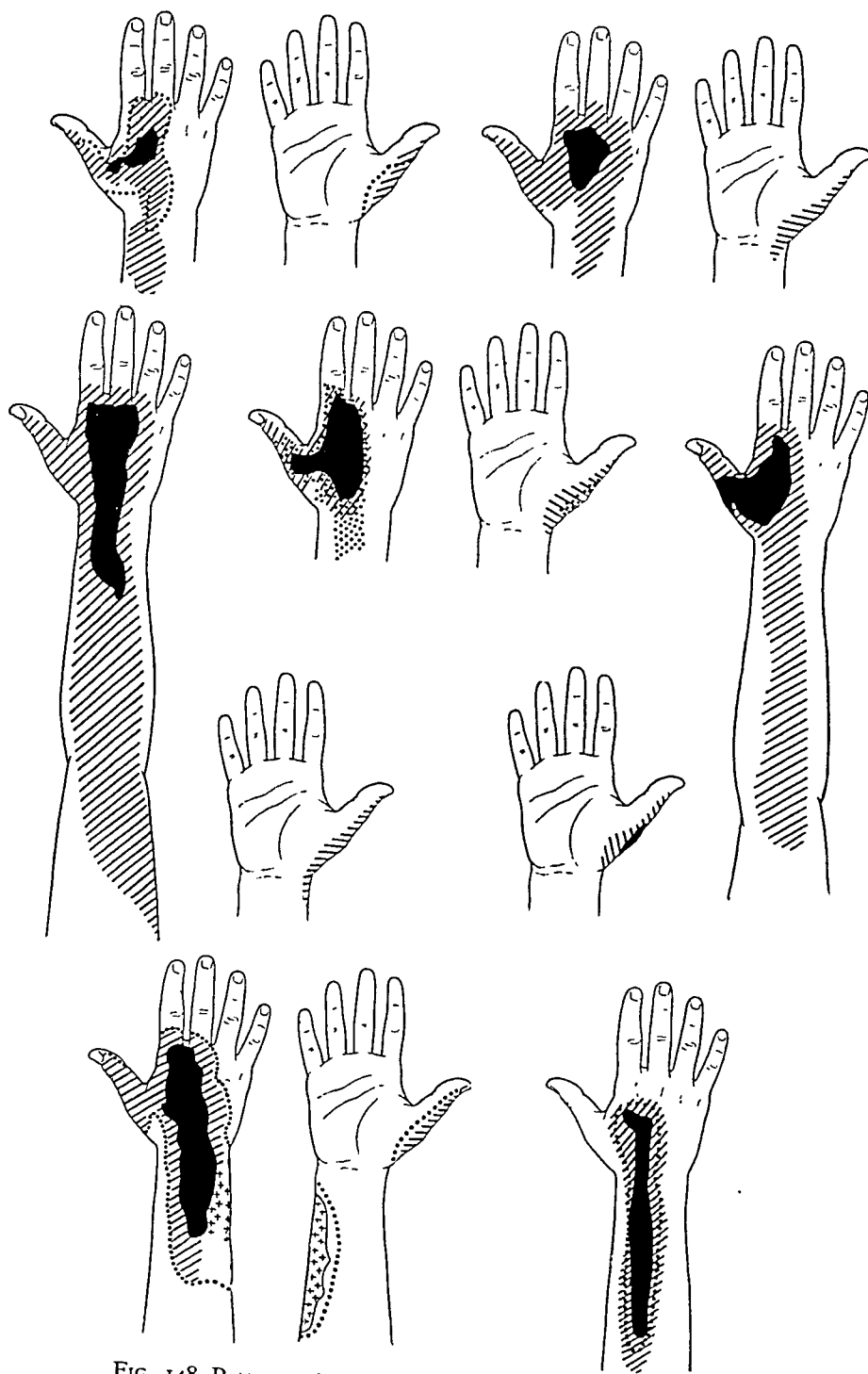


FIG. 148. Patterns of sensory loss in radial nerve lesions.

[[578]]

suture, showed a wide variety of areas of analgesia and in one case no analgesia at all (Fig. 147). Head and Sherren's Case 44 of division of the radial nerve where it passes under the tendon of the brachioradialis likewise showed no loss to prick pain.

Although not infrequently recorded, we have not observed any case of radial nerve lesion which did not show loss of sensation to touch. Of all the peripheral nerves, the radial shows the greatest variation in the areas of loss of sensation to both epicritic and protopathic sensation. This is due to the fact that six nerves are concerned with the sensory supply of the dorsum of the hand; the median, superficial radial, external cutaneous branch of the radial, musculocutaneous and ulnar. Stopford emphasized, as did Head and Sherren, the importance of the musculocutaneous nerve in the supply of the dorsum of the hand, and states that its terminal branches may extend onto the dorsum of the metacarpus, and "it appears that the extent of its distribution varies inversely with that of the radial." Although this may be true, it must not be forgotten that the median nerve must be considered in the supply of sensation to the dorsal area over the distal portion of the metacarpus and the distal portion of the thumb. (Fig. 148.)

One of the reasons for varying reports relative to the sensory loss in radial nerve lesions is the hairy nature of the area of skin under investigation. The early return of hair sensibility frequently is confused with the presence of sense of touch. The skin must be closely shaven in all cases when examination of touch is contemplated. When examinations were made in the presence of hair, areas sensitive to "touch" frequently were analgesic.

Vasomotor or secretory disturbances are absent or very slight and usually occur as the result of a complicating vascular, osseous, articular or muscular injury. At times slight edema and some induration of the skin over the dorsum of the forearm have been observed.

## LEVEL OF LESION

If in addition to a paralysis of the muscles supplied by the radial nerve the deltoid is paralyzed, the lesion involves the

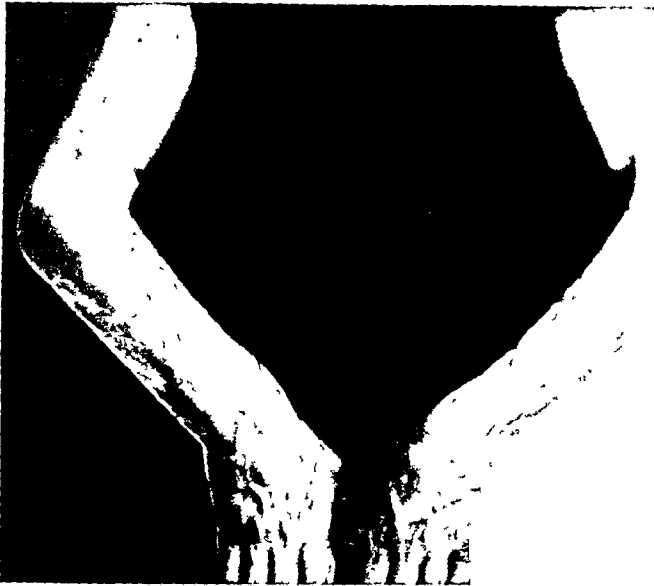


FIG. 149. Method of testing paralysis of brachioradialis muscle.

posterior cord of the brachial plexus. In the middle of the forearm, a wound may produce only a partial paralysis of the triceps, since the branches to the long and inner heads of the muscle may come off at a higher level. In the lower fourth of the arm the branches to the brachioradialis, and less frequently the extensor carpi radialis, may have been given off at a higher level (Fig. 149).

## PARTIAL LESIONS

It is significant that in lesions of the radial in the arm it is usual to find all the muscles below the innervation to the brachioradialis paralyzed, irrespective of the severity of the lesion. However, it may be noted that at times the extensors of the wrist may be paralyzed and those of the fingers remain unaffected. Again, only the extensor of the middle finger may be

unimpaired (Fig. 150). Occasionally the extensors of the thumb and fingers may be involved, whereas the extensors of the wrist are spared (Figs. 151 and 152). The constancy of certain partial



FIG. 150. Partial conservation of extensor to middle finger in radial nerve lesion.

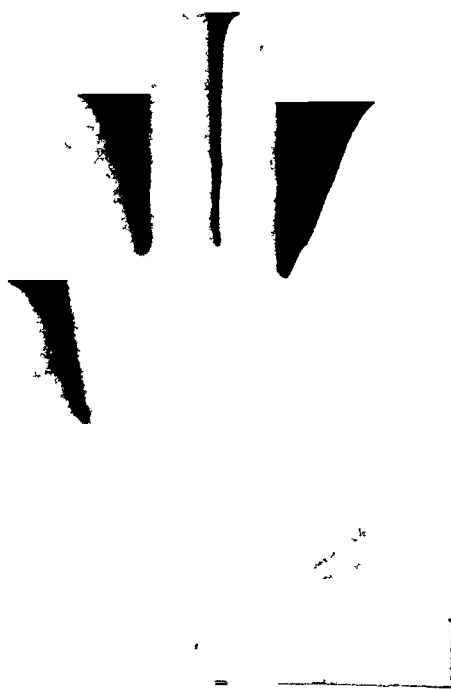


FIG. 151. Paralysis of extensors of thumb and index finger in radial nerve lesion.

lesions of various nerves has been attributed to the intraneural localization of fibers which supply certain muscles, as has been

pointed out by Stoeffel, Marie, Meige, Gosset, Dejerine and Mouzon, and Krauss and Ingham. However, it may be well to remember that Dustin believes that he has shown conclu-



FIG. 152. Paralysis of extensors of thumb in radial nerve lesion.

sively that between each branch of a nerve there is a reassembling of nerve fibers in the form of an intraneural plexus, so that a long intraneural pathway does not exist.

#### MUSCLE ATROPHY

Muscular atrophy is noted two or three months after the injury and may become so marked that it appears as if the skin and subcutaneous tissue were adherent to the posterior aspect of the ulna and radius.

#### SIGNS OF MOTOR RECOVERY

According to Oppenheim, the muscles recover in direct relation to the length of the regenerating nerve fibers. This does not appear to be the case. Bénisty stated that the order of recovery is nearly always the same. The common extensor is restored only after the radial extensors. Usually the extensors

of the middle, ring and little fingers begin to recover first; but sometimes it is the index and middle fingers which first recover their movements. The extensors of the thumb and the adductor



FIG. 153. Recovery of radial nerve palsy following neurolysis. Note recovery of extensors of wrist and supplementary movement of index finger.



FIG. 154. Recovery of extensors of wrist but not of thumb or fingers.

of the thumb regain their power last of all. From the available observations of the United States war material, a marked difference is seen in that the extensors of the thumb recovered before those of the fingers. As to the order of recovery of the extensors of the fingers and thumb, those of the thumb showed some recovery in over 50 per cent of our cases, but when this did not occur the thumb was almost the last to recover. The extensor of the middle finger was one of the first to recover in over 50 per cent of cases and the index finger was last in one-



third of the number of cases. Rarely, return of function was seen in the long abductor of the thumb before that in the extensors of the wrist (Figs. 153, 154, 155).



FIG. 155. Recovery of extensors of wrist and partial recovery of extensors of fingers.

Simultaneous extension of the wrist and all of the fingers seems to be the final stage in recovery of voluntary movement. Pitres suggested two tests for determining the completeness of recovery in radial nerve paralysis. The first test consists in placing the arm in the attitude of a man taking an oath with the wrist and fingers extended, the thumb raised and separated from the fingers with the tendons of the extensors and the long abductor of the thumb marking out the anatomical snuff box. Then the patient is requested to supinate his hand. The second test consists of the patient placing his little finger on the seam of his trousers, with his fingers well extended and with the palm turned to the front (Fig. 156).

#### SIGNS OF SENSORY RECOVERY

Here, as in other nerves, interlacing of the borders of the loss of sensation to heat, cold, pain and touch and recovery of tactile sensibility, particularly in islands away from the border of former loss, constitute evidence of recovery.

Radial nerve lesions in many instances showed areas of loss of cold with recovery of tactile sensation. In lesions of this nerve, the return of sensibility to pain alone cannot be given

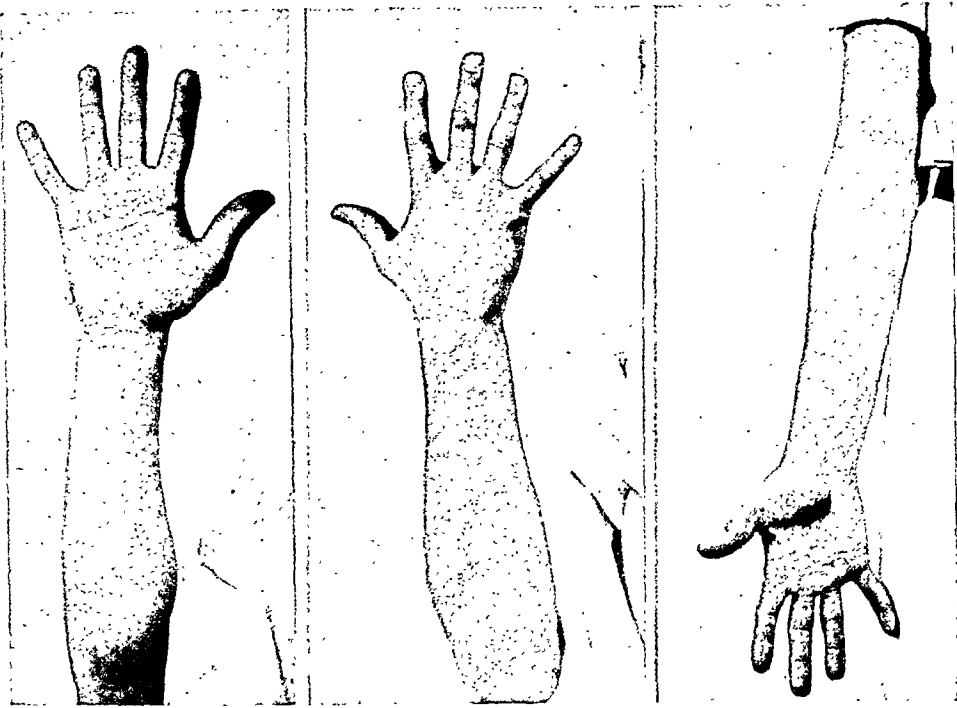


FIG. 156. Tests for complete recovery of motor function in radial nerve lesion.

much weight in relation to regeneration, because of the very wide overlap of adjacent nerves. Patchy return of sensation, interlacing of the borders of loss to cold, areas of recovery of tactile sense and not of cold, and the reverse, as well as the recovery of tactile sense in the sensory supply of the nerve, served to determine the existence of a process of recovery. In some cases an area of widespread anesthesia was present, but a deep indentation pointed to the correct diagnosis. Similarly, a wide area of anesthesia and analgesia would have been deceptive had not the border of the loss to cold been well outside this area and interlacing of cold been present (Fig. 157).

Bénisty refers to a diffuse, burning pain which follows pinching of a formerly anesthetic area as an early sign of

regeneration. This may occur but it is not an accurate indication. Neither have we found Tinel's sign to be entirely reliable.

Due to the extensive overlap of adjacent nerves, there is no

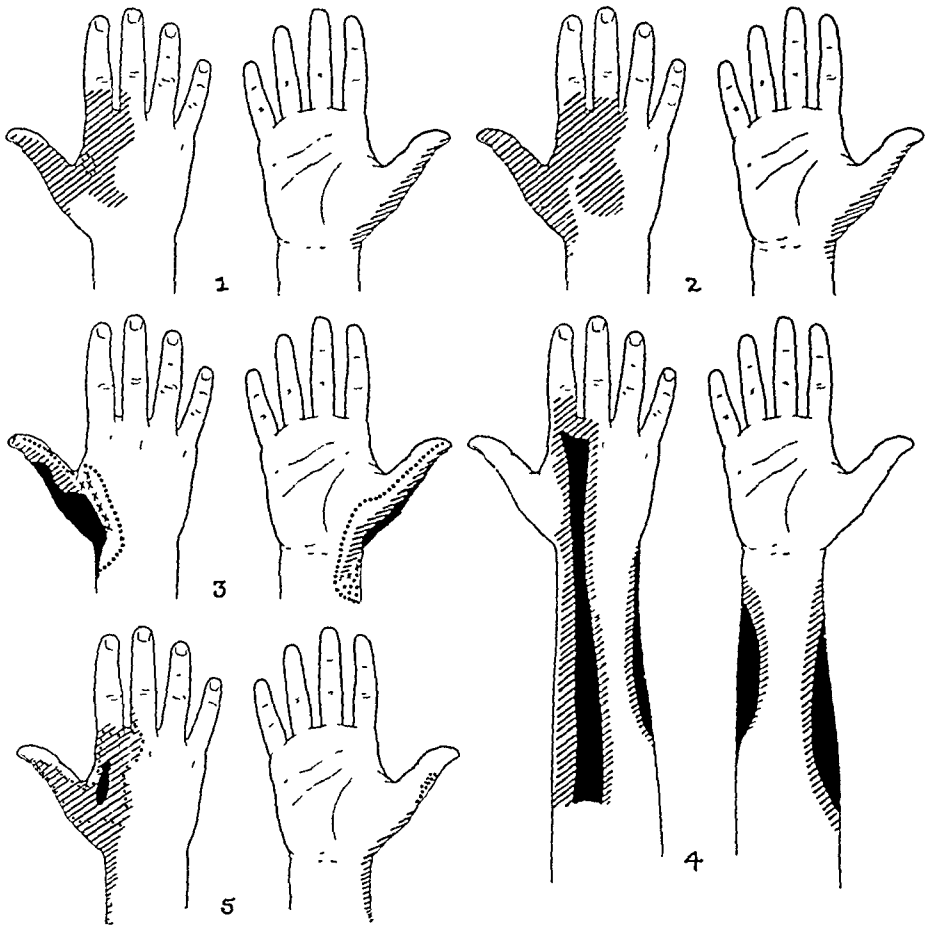


FIG. 157A. Radial nerve lesions which recovered spontaneously.

1. Recovery of pain, small area of loss of cold.
2. Recovery of pain and cold.
3. Injury of superficial sensory nerve, recovery of touch, not pain.
4. Recovery of all motor branches, marked sensory loss.
5. Recovery of cold, not touch.

isolated area of sensory supply of the radial nerve, and special attention must be given to the general principles indicated above. Return of sensation to milder degrees of heat and cold

within an area anesthetic to tactile stimulation, or the return of tactile sensibility within the area of loss to mild cold or heat, are certain signs of recovery.

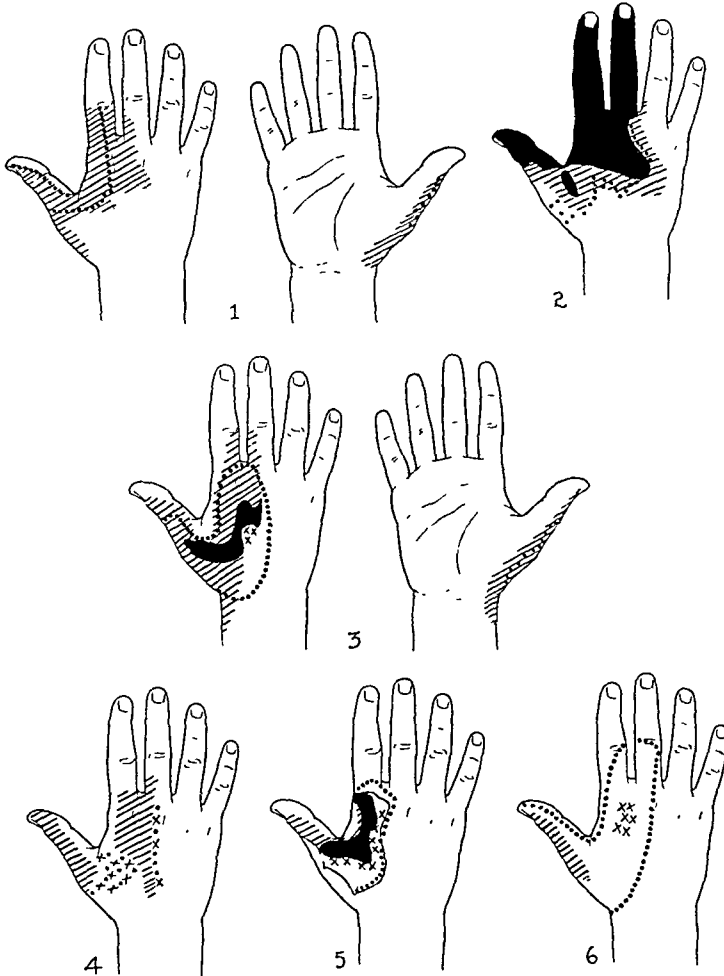


FIG. 157B. Radial nerve lesions which recovered after operation.

1. Return of pain, not cold.
2. Radial and median nerve lesion showing considerable analgesia; island of analgesia.
3. Recovery of touch, not cold, and recovery of touch and not pain.
4. Return of touch, not pain, in a patch; shaded area showed only tactile hypesthesia.
5. Return of touch, not pain or cold.
6. Return of touch and pain, not of cold.

### DIFFERENTIAL DIAGNOSIS

The diagnosis of an injury to the radial nerve is usually made readily. Vascular lesions, ischemic paralysis, bony

ankylosis and, especially, injury to tendons may lead to confusion. In cases of severed tendons, although no movement of the hand or fingers is produced, electrical stimulation produces contraction of the muscles suspected of being paralyzed. The same is true in ankylosed and painful joints. In ischemic paralysis muscles are involved other than those supplied by the radial nerve; the reaction of degeneration does not occur and the sensory loss is inconstant and does not follow the anatomic distribution of the nerve. The condition known as "congealed hand" due to "physiopathic reflex nervous disturbance" may offer some difficulty in diagnosis, but the lost motion is not limited only to the muscles supplied by the radial nerve. In such cases electrical excitability is increased, the extremity is cold, the pulse small, and the sensory loss, if any be present, does not follow any anatomic distribution.

#### ANATOMY

The radial nerve is one of the two branches of the posterior cord of the brachial plexus. Therefore, it consists of fibers of the posterior divisions of all of the spinal nerves which form the brachial plexus. It is the largest branch of the brachial plexus.

In the axilla the radial lies beneath the axillary artery which gives off a branch to supply the nerve. The other nerves in the axilla are on a plane anterior to the radial. The median is separated from it by the axillary artery and the musculocutaneous lies still more anteriorly. The ulnar and internal cutaneous nerves to the arm and forearm are anterior and medial to it.

The radial crosses the anterior surface of the tendons of the *teres major* and *latissimus dorsi* muscles. It has variable relations to the numerous branches of the axillary artery which arise at this level. In many instances the inferior scapular artery arises from the axillary external to the nerve and the latter then crosses its anterior surface to reach the triangular space bounded by the subscapular, *teres major* and the long head of the *triceps* muscles.

The nerve continues downward into the arm after entering the fascial plane between the long and lateral heads of the triceps. It lies closely applied to the inner side of the humerus. It then descends along the posterior surface of the humerus in the spiral groove. It is completely masked by the lateral head of the triceps. In its course across the posterior surface of the humerus the nerve is accompanied by the superior profunda artery. At the lateral side of the humerus the artery gives off two branches, the smaller of which accompanies the nerve. The larger branch of the artery passes down along the posterior surface of the intermuscular septum to the level of the lateral condyle of the humerus (Fig. 158).

About 10 cm. above the lateral epicondyle the nerve, with its artery, pierces the external intermuscular septum and descends on the anterior aspect of the arm, lying upon the anterior surface of the brachialis anticus muscle. The brachioradialis lies anterior and lateral while the tendon of the biceps lies anterior and medial to the nerve. At the level of the lateral condyle of the humerus or slightly above, the radial divides into its terminal branches, the *posterior interosseous* and the *superficial radial* nerves. It is obvious that the radial lies medial, posterior, lateral and anterior to the humerus as it passes from its origin to the point at which its terminal branches arise.

As the radial lies medial to the humerus three branches are given off close together. The *internal cutaneous branch* must not be confused with the medial cutaneous nerve to the arm. It arises from the nerve in the axilla and crosses the anterior surface of the teres major and latissimus dorsi tendons. It descends along the medial border of the long head of the triceps and finally passes posterior to that muscle to perforate the aponeurosis on the posterior surface of the arm. Its terminal twigs anastomose freely with those of the internal cutaneous nerve of the arm. The *muscular branch* to the *long head* of the *triceps* is usually 3 to 4 cm. long. It descends along the medial border of the muscle and divides into two or three branches which ramify upon the anterior surface of the muscle before

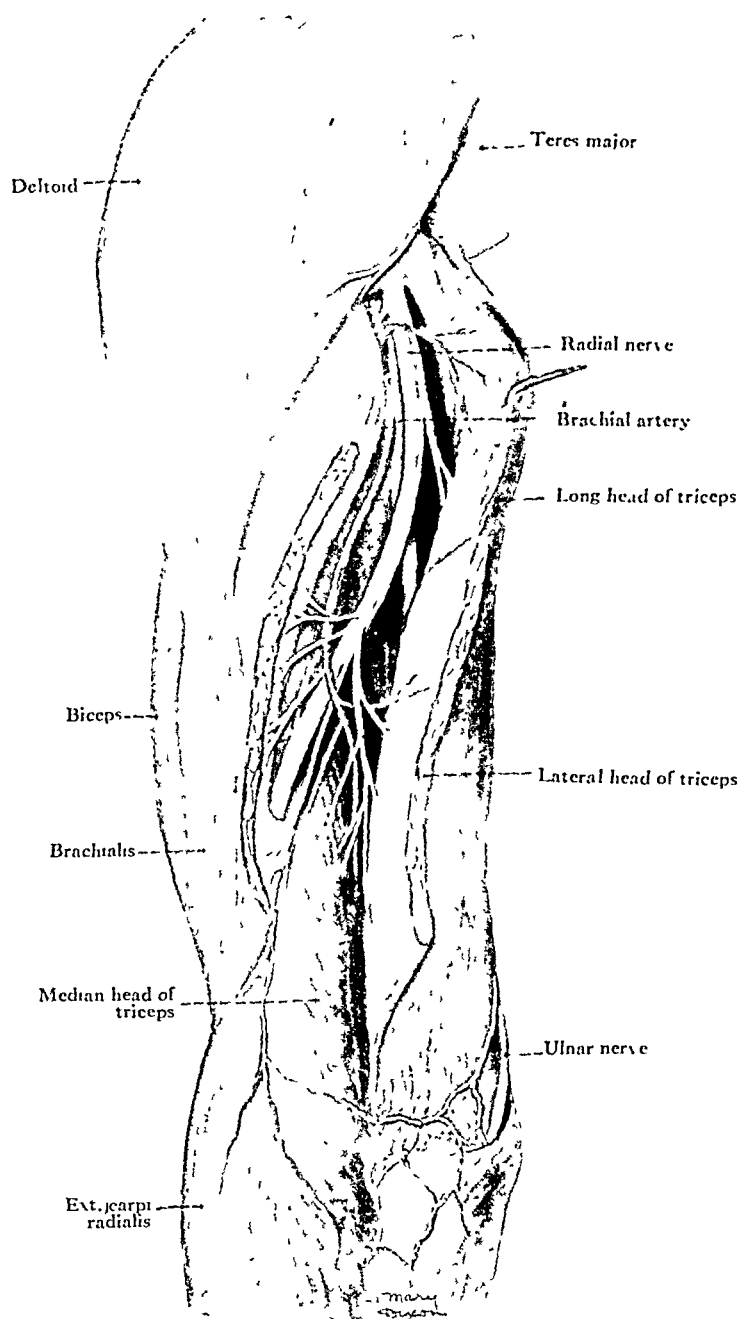


FIG. 158. Anatomical course of radial nerve in arm.

penetrating it. The *superior branch* to the *medial head* of the *triceps* arises from the radial in the axilla just below the branch to the long head. It may be contained in the same sheath with the ulnar and thus it is also known as the ulnar collateral. At a variable level it penetrates and supplies the medial head of the triceps.

As the radial lies posterior to the humerus several branches are given off. The *muscular branch* to the *lateral head* of the *triceps* passes downward and externally and quickly divides into numerous twigs which penetrate the medial side of the lateral head. The *inferior branch* to the *medial head* of the *triceps* is the principal nerve supply to this muscle. It also innervates the anconeus muscle and the elbow joint. It follows the trunk of the radial in the groove and lies parallel to the superior edge of the medial head. It is easy to trace as it passes downward because of the numerous branches it gives to this muscle. At the lower border of the medial head of the triceps it supplies the anconeus with numerous twigs. Throughout its course it is accompanied by a small artery, a branch of the profunda. The *external cutaneous nerve* arises from the radial as it courses through the spiral groove. It is quite large and quite frequently parallels the main nerve trunk. It perforates the lateral head of the triceps and the brachial aponeurosis at a variable point above the epicondyle. It then divides into a superior and an inferior branch which supply the skin over the lateral surface of the arm and the dorsal surface of the forearm. These branches anastomose with branches of the musculocutaneous and medial cutaneous nerve to the arm.

As the radial lies anterior to the intermuscular septum it gives off a branch to the *brachialis anticus* muscle. At a slightly lower level, about 5 to 6 cm. above the medial condyle, the branch to the *branchioradialis* arises from the lateral border of the nerve. Approximately 1 cm. lower the branch to the *extensor carpi radialis longus* muscle arises from the lateral side of the nerve. Stookey points out that the branch to the *extensor carpi radialis brevis* muscle arises from the same



funiculus as the former branch. It has a long extraneural course before it supplies the muscle.

The radial ends a few centimeters above the lateral condyle of the humerus where it divides into two terminal branches; the *superficial radial* and the *posterior interosseous nerves* (Fig. 159).

The superficial radial nerve is the smaller of the two and descends lateral to the biceps tendon. It lies beneath the brachioradialis muscle upon the brachialis anticus and is accompanied by the anterior recurrent radial artery. At the junction of the middle and inferior thirds of the forearm the nerve passes externally between the tendon of the brachioradialis and the radius. It reappears at the lateral border of the brachioradialis tendon between it and the extensor of the thumb. Here it perforates the aponeurosis. In its course through the forearm the nerve is related closely to the radial artery. If the nerve is not found in the vascular sheath, it is contained in the fascial sheath of the brachioradialis. About 4 cm. below the styloid process of the radius the nerve divides into its terminal branches. Usually these are two; one external and one internal. The external branch lies behind the tendon of the long abductor and courses in the subcutaneous tissue on the dorsum of the thumb, often as far as the terminal phalanx. Occasionally small collaterals of this branch may reach the skin over the thenar eminence. The *internal* branch is larger and soon after its origin gives off twigs to supply the skin on the dorsal surface of the wrist. Some of these anastomose with the dorsal cutaneous branches of the ulnar. In the first interosseous space it divides into the dorsal digital nerves on the radial and ulnar sides of the index finger and the radial side of the middle finger.

The posterior interosseous nerve is more deeply placed than the superficial radial. It lies for a short distance in the external bicipital groove and then passes between the brachioradialis and brachialis anticus muscles. It is crossed by rather large arterial branches which supply the muscles in this area.

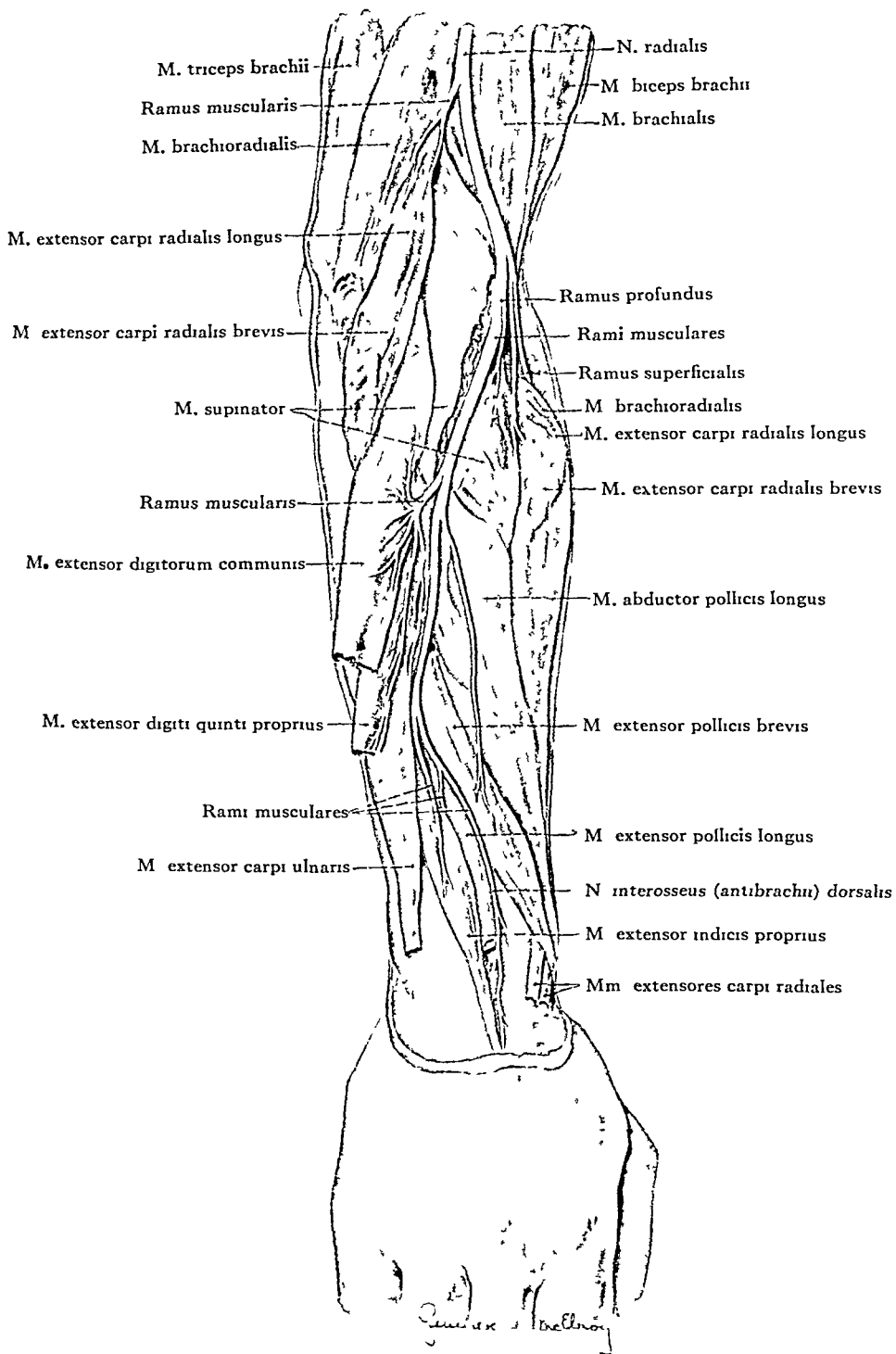


FIG. 159. Anatomical course of radial nerve in forearm.

The nerve then passes to the outer side of the radius beneath the external carpi radialis longus and brevis muscle. It turns around the head of the radius in an oblique manner and pierces the supinator brevis muscle to which it gives branches. It now occupies the space between the two superficial and deep muscular layers on the posterior aspect of the forearm. Just below its exit from the supinator brevis the posterior interosseous nerve ends by dividing into two or more main twigs which again rapidly divide. The nerve becomes flattened and bandlike and loses the appearance of a nerve trunk. Of these terminal branches one is relatively large and has a short extramuscular course before it supplies the extensor digitorum communis, the extensor carpi ulnaris and extensor digiti quinti proprius muscles. The other terminal branches have a long extramuscular course and supply the abductor pollicis longus, extensor pollicis brevis and extensor indicis proprius muscles.

#### PHYSIOLOGY

The radial nerve may be called the nerve of extension. The *triceps* muscle extends the forearm upon the arm. Duchenne has shown that the long head of the triceps is the weakest because it has no stability in its upper attachment. The *anconeus* also extends the forearm and even when the triceps is completely paralyzed its strength of action is such that it alone can extend the forearm.

In spite of its old name the *brachioradialis* (supinator longus) forcibly flexes the forearm upon the arm when the hand is held midway between supination and pronation. The *supinator brevis*, on the contrary, is a supinator exclusively. The *extensor carpi radialis brevis* simply extends and abducts the hand while the *extensor carpi ulnaris* extends and adducts the hand.

The *extensor communis digitorum*, *extensor indicis proprius* and *extensor minimi digiti quinti* muscles extend the first phalanx of the fingers on the metacarpal bones and only the

first phalanx. Extension of the second and distal phalanges is accomplished by the interossei and lumbricales.

The *extensor pollicis longus* extends the two phalanges of the

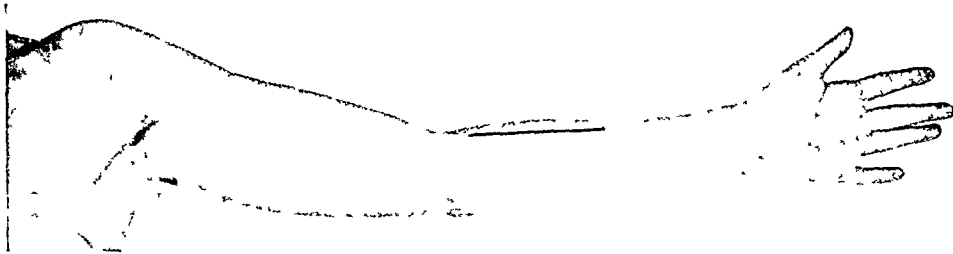


FIG. 160. Line of incision to expose radial nerve in axilla.

thumb and at the same time slightly extends the hand. The *extensor pollicis brevis* is a direct abductor of the first metacarpal and is the only muscle to perform this action. The *abductor pollicis longus* draws the first metacarpal obliquely outward and forward. In addition, its complete contraction flexes the hand and inclines it outward.

### SURGERY

Lesions of the radial within the *axilla* are usually associated with vascular injury. The method of exposure is similar to that employed in low brachial plexus lesions. The arm is placed at right angles to the body and in external rotation. The incision may be a straight one from the base of the axilla to the middle of the humerus and parallel to the medial edge of the coracobrachialis muscle (Fig. 160). The deep fascia is divided and the neurovascular bundle is exposed. The nerve may be exposed between the axillary vein and the median nerve or it may be isolated by retracting the entire neurovascular bundle. To accomplish the latter it is necessary to ligate some of the small branches of the brachial artery and vein. The nerve should be identified as it passes over the tendon of the latissimus dorsi muscle. In this position it is accompanied by the superior profunda artery. In the order of appearance the branches of the radial at this level are the internal cutaneous, branches to

the long head of the triceps, the ulnar collateral branch for the medial head of the triceps and anconeus and the branch for the lateral head of the triceps. Some of the internal fibers of the medial head of the triceps may be severed to afford a satisfactory exposure of the nerve as it enters the groove on the posterior surface of the humerus.

As the nerve passes through the groove on the dorsal surface of the humerus, it is accompanied by the superior profunda artery and vein, both of which lie to its lateral side. The nerve, it will be remembered, is in direct contact with the humerus and is commonly injured in fractures of the middle third of the bone. It may be crushed by the trauma which produces the fracture or it may be stretched or traumatized by the bone fragments at the time of the injury or during efforts at reduction. Not infrequently the nerve may be found buried in the callus formed as the fractured ends unite. The nerve may be exposed in this situation by one of several methods. The almost vertical course of the radial is not appreciated fully. It has a spiral course only in a small part of the middle third. Thus there are certain disadvantages to a spiral incision which attempts to parallel the course of the nerve. In such an exposure a portion of the triceps must be cut transversely.

The most satisfactory incisions are those which are longitudinal in direction. An incision may be made from a point 7 cm. below the posterior angle of the acromion to another point about 5 cm. below the insertion of the deltoid muscle (Fig. 161). This should be placed in the middle of the posterior surface of the arm along a straight line which extends from this angle of the acromion to the tip of the olecranon. The deep fascia is incised and the plane of cleavage between the long and lateral heads of the triceps is deepened until the glistening aponeurosis upon their ventral surfaces is exposed. The separation of the heads of the triceps should be carried to the upper and lower angles of the wound. The posterior fibers of the deltoid should be retracted and if necessary some of these may be divided. The aponeurosis on the ventral surface

of the tricipital heads should be opened with care because the nerve lies just beneath.

When a large amount of scar tissue is present it is often



FIG. 161. Line of incision to expose radial nerve in upper arm.

necessary to supplement this dorsal incision with a lateral one which exposes the nerve as it appears on the lateral surface of the arm, after it has penetrated the external intermuscular septum. The lateral head of the triceps is separated from its septal attachment and is retracted dorsally. This will expose the lateral portion of the radial groove. A tape may be passed beneath the muscle and its ends used as a retractor so that the nerve may be followed throughout its course in the groove. Great care should be used to prevent injury to the tricipital branches.

In the lower third of its course in the arm the nerve may be exposed by a longitudinal incision which extends from the insertion of the deltoid to a point between the tendon of the biceps and the external condyle of the humerus (Fig. 162.) The cephalic vein is divided in the lower part of the incision and the lateral cutaneous nerves, if encountered above, may be sacrificed. The line of cleavage between the brachioradialis muscle laterally and the biceps and brachialis anticus muscles medially is deepened and these muscles are retracted. In this cleft the nerve with a small terminal branch of the superior profunda artery is found. The nerve should be identified well above the lesion and great care must be taken to preserve the motor branches which are given off in this location.

If sufficient exposure is not obtained a third incision between these two and parallel to the upper one may be made

from just above the deltoid insertion downward. It is carried through the triceps, the fibers of which are separated in a longitudinal direction. The aponeurosis described previously

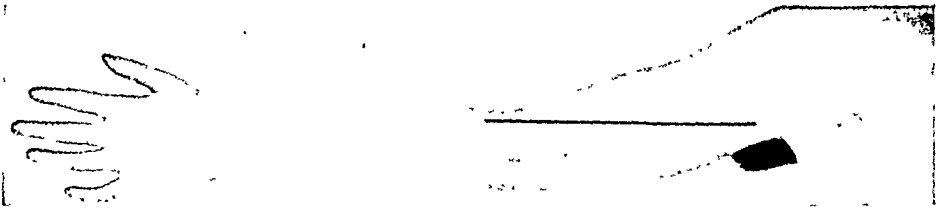


FIG. 162. Line of incision to expose radial nerve in lower arm.

and the nerve from the lower border of the *teres major* muscle to the antecubital fossa, are exposed with the least damage to the surrounding structures.

When it is necessary to prepare a new nerve bed for the radial because of extensive scar tissue or callus, its course may

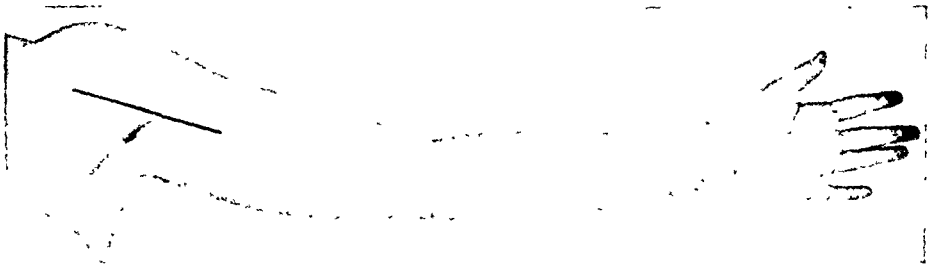


FIG. 163. Line of incision to expose posterior interosseous nerve.

be changed from the groove in the humerus to a lower position where it may be placed behind the medial head of the triceps. This requires that the nerve be mobilized throughout its lateral portion and that the lateral head of the triceps be separated from the external intermuscular septum low down.

To expose the *posterior interosseous nerve*, the terminal motor divisions of the radial, the arm is slightly flexed and the hand is placed in semipronation. The lateral condyle and the radial border of the common extensor muscle are identified. An incision is made from the lateral condyle down along the line between the *extensor digitorum communis* and the *extensor carpi radialis longus* and *brevis* through the deep

fascia (Fig. 163). The line of cleavage between them is found at the lower angle of the wound and this is deepened and carried upward to their common origin. Here the muscle fibers are

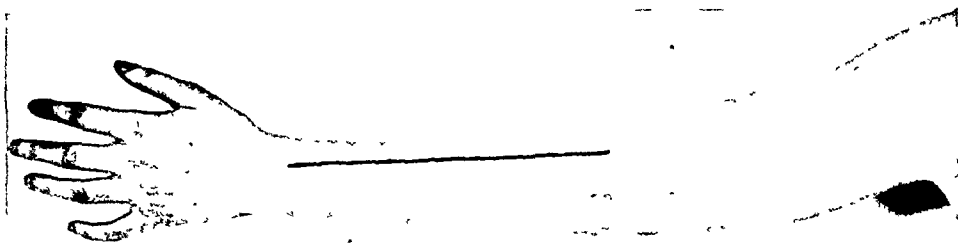


FIG. 164. Line of incision to expose superficial radial nerve.

divided parallel to their direction as far as the lateral condyle. By retraction of these muscles the obliquely directed fibers of the supinator brevis are identified. It will be remembered that the nerve lies within or beneath the supinator brevis and that it runs at right angles to the muscle fibers. About 4 cm. below the condyle the supinator brevis fibers should be divided parallel to their course and in this opening the flat nerve will be found.

The superficial *radial* nerve is the sensory terminal of the radial and is seldom if ever exposed for repair. It is, however, used as a graft for repairing continuity defects. It may be exposed by an incision which begins just above the bend of the elbow, midway between the biceps tendon and the external condyle of the humerus (Fig. 164). It should be carried down the radial surface of the forearm parallel to the medial border of the brachioradialis which is retracted. The nerve passes along the under surface of this muscle.

To overcome a large defect in the continuity of the radial in its middle third, it may be necessary to transpose the nerve to the anterior surface of the humerus. The nerve is exposed and mobilized in the upper part of the arm. The motor branches to the triceps are given off at this level and must be saved. The nerve should be exposed in the lower third of the arm and mobilized upward from the antecubital fossa. The numerous motor branches near the elbow must be carefully safeguarded.



The nerve should be freed from the scar tissue or callus in which it is embedded, but the neuromas on the central and distal ends should not be removed until the nerve has been transposed. Identification sutures should be placed in the sheath of the central and distal ends so that the nerve will not be rotated during the operation. The central end of the nerve should be withdrawn from the radial groove through the opening in the medial head of the triceps which it traverses normally. The distal end is passed in front of the humerus in a tunnel made beneath the brachialis anticus or it may be placed superficial to that muscle and beneath the biceps. The neuromas are resected and an end-to-end suture performed. Further relaxation may be obtained by flexion and adduction of the arm. By this method a defect of as large as 12 cm. may be bridged.

This method of transposition is to be used only in selected instances. If the nerve supply to the triceps muscle is endangered in the operation it should be abandoned since extension of the forearm is more valuable than extension of the wrist or fingers. The latter may be obtained, if necessary, by various tendon operations to be described later.

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